

# **NOTICE**

**All drawings located at the end of the document.**

44746

**TECHNICAL MEMORANDUM NO. 4**

**HUMAN HEALTH RISK ASSESSMENT  
CHEMICALS OF CONCERN IDENTIFICATION  
OPERABLE UNIT 3**

**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**

**U.S. DEPARTMENT OF ENERGY  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO**

**ENVIRONMENTAL RESTORATION PROGRAM**

**SEPTEMBER 23, 1994**

**DOCUMENT CLASSIFICATION  
REVIEW WAIVER PER  
CLASSIFICATION OFFICE**

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## LIST OF ACRONYMS AND ABBREVIATIONS

The following is a list of acronyms used throughout this technical memorandum.

Al	aluminum
Am	americium
ARC/INFO	Geographical Information System software
As	arsenic
BGCR	Background Geochemical Characterization Report
BKGND	background data as listed in summary statistics tables and figures
BM	benchmark
CaCO <sub>3</sub>	calcium carbonate
CDPHE	Colorado Department of Public Health and the Environment (formerly Colorado Department of Health [CDH])
cm	centimeter
COC	Chemicals of Concern
Cs	cesium
DBMS	Database Management System
DOE	U.S. Department of Energy
DQO	data quality objective
EE	Environmental Evaluation
EPA	U.S. Environmental Protection Agency
Fe	iron
GIS	Geographic Information System
GW	groundwater
HHRA	Human Health Risk Assessment
IHSS	Individual Hazardous Substances Site
IAG	Interagency Agreement
Jeffco Area	Jefferson County Remedy Acres
LHSU	lower hydrostratigraphic unit
µg/L	micrograms per liter
meq/L	milliequivalents per liter
mg/kg	milligrams per kilogram
Mn	manganese
OU 3	Operable Unit 3
Pb	lead
pCi/g	picocuries per gram
PCOC	potential chemical of concern
PRG	Programmatic Preliminary Remediation Goal
PROBPLOT	probability plot analysis tool
PT	pit trench soil
Pu	plutonium
QA/QC	quality assurance/quality control
Ra	radium
RAAMP	Rocky Flats Radionuclide Ambient Air Monitoring Program
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose

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RFEDS	Rocky Flats Environmental Database System
RFI	RCRA facility investigation
RFP	Rocky Flats Plant
RI	Remedial Investigation (CERCLA)
RPDs	relative percent differences
SD	sediment (as used in some tables and figures)
SED	sediment (as used in some tables and figures)
Sr	strontium
SS	surface soil
SW	surface water
TAL	target analyte list
TDS	total dissolved solids
Th	thorium
Tl	thallium
TM	technical memorandum
TMETAL	total metals
TOC	total organic carbon
TRADS	total radionuclides
U	uranium
UCL	upper confidence limit
UHSU	upper hydrostratigraphic unit
UTL	upper tolerance limit
VOA	volatile organic analysis
VOCs	volatile organic compounds
WRS	Wilcoxon Rank Sum



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## EXECUTIVE SUMMARY

The purpose of this Identification of Chemicals of Concern Technical Memorandum No. 4 (TM) is to present the Chemicals of Concern (COCs) for the Rocky Flats Environmental Technology Site (RFETS) Operable Unit No. 3 (OU 3) Human Health Risk Assessment (HHRA).

The COC selection process was developed as part of the Data Aggregation process used in the RFETS HHRAs by the U.S. Environmental Protection Agency (EPA), the State of Colorado Department of Public Health and the Environment (CDPHE), and the U.S. Department of Energy (DOE). Guidance for the Data Aggregation process was provided in a memorandum from DOE (DOE, 1994a) and at a presentation by CDPHE, EPA, and DOE on June 3, 1994 (CDPHE/EPA/DOE, 1994). The COC selection process is being used in conjunction with the CDPHE Conservative Screen (DOE, 1994d) to aggregate the OU 3 data for the characterization of potential OU 3 risks. The CDPHE Conservative Screen is used to identify the areas of the OUs that may be impacted by chemicals. The COCs will be used in the HHRA to quantify potential risk to exposed receptors.

The COC selection process was applied to concentration/activity data for each of the following IHSSs and media:

IHSS 199, Contamination of Soils:

- Surface soils

IHSS 200, Great Western Reservoir:

- Surface sediments
- Subsurface sediments
- Surface water
- Groundwater

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**IHSS 201, Standley Lake:**

- Surface sediments
- Surface water
- Groundwater

**IHSS 202, Mower Reservoir:**

- Surface sediments
- Surface water

The COC selection process identifies the chemicals detected in OU 3 that contribute significantly to potential risks to human receptors. The objective of the process is to identify those chemicals in a particular medium that, based on concentration and toxicity, contribute significantly to risks calculated for exposure scenarios involving that medium (EPA, 1989a). The COCs will be used in the HHRA to quantify risks associated with exposure to OU 3 media. The COC selection process was agreed upon by EPA, CDPHE, and DOE and is based on Risk Assessment Guidance for Superfund (EPA, 1989a), the Interagency Agreement (IAG) (IAG, 1991), and site-specific guidance (CDPHE/EPA, 1993; DOE, 1993a; CDPHE/EPA/DOE, 1994, and EPA, 1994).

The COC selection process includes an application of the following:

1. Statistical background comparison tests
2. A frequency of positive detection screen
3. An essential nutrient screen
4. A concentration-toxicity screen
5. A comparison to Programmatic Preliminary Remediation Goals (PRGs) (DOE, 1994b).

A weight-of-evidence evaluation (EPA, 1994) was employed for those media that did not undergo the statistical background comparison tests (see Subsection 3.7 for details). The

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evaluation uses the results of these screening processes and information regarding the nature and extent of contamination within OU 3 to assess if a chemical is a COC.

The results of the COC selection process are shown in Table ES-1 for each medium and each IHSS.

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TABLE ES-1  
 RESULTS OF COC SELECTION PROCESS

IHSS	Surface Soil	Surface Sediment	Subsurface Sediment	Surface Water	Groundwater
199 Contamination of Soils	<sup>239/240</sup> Pu <sup>241</sup> Am	NA	NA	NA	NA
200 Great Western Reservoir	NA	<sup>239/240</sup> Pu	--	--	--
201 Standley Lake	NA	--	--	--	--
202 Mower Reservoir	NA	--	--	--	--

Notes:  
<sup>239/240</sup>Pu = plutonium <sup>239/240</sup>  
<sup>241</sup>Am = americium <sup>241</sup>  
 NA = Not applicable.  
 - = No COCs were identified.

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## 1.0 INTRODUCTION

### 1.1 PURPOSE

The purpose of this Identification of Chemicals of Concern Technical Memorandum (TM) No. 4 is to present the Chemicals of Concern (COCs) for the Rocky Flats Environmental Technology Site (RFETS) Operable Unit No. 3 (OU 3) Human Health Risk Assessment (HHRA). The HHRA will assess potential human health risks for receptors exposed to the COCs under current and likely future land-use conditions. The HHRA supports the Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) report. The COC selection process was developed by the U.S. Environmental Protection Agency (EPA), the State of Colorado Department of Public Health and Environment (CDPHE), and the U.S. Department of Energy (DOE) as part of the Data Aggregation process used in the RFETS HHRA (Figure 1-1). The COC selection process is being used in conjunction with the CDPHE Conservative Screen (DOE, 1994d) to aggregate the OU 3 data for the characterization of potential OU 3 risks. The CDPHE Conservative Screen is used to identify the areas of the OUs that may be impacted by chemicals. Guidance for the Data Aggregation process was provided in a memorandum from DOE (DOE, 1994a) and at a presentation by CDPHE, EPA, and DOE on June 3, 1994 (CDPHE/EPA/DOE, 1994).

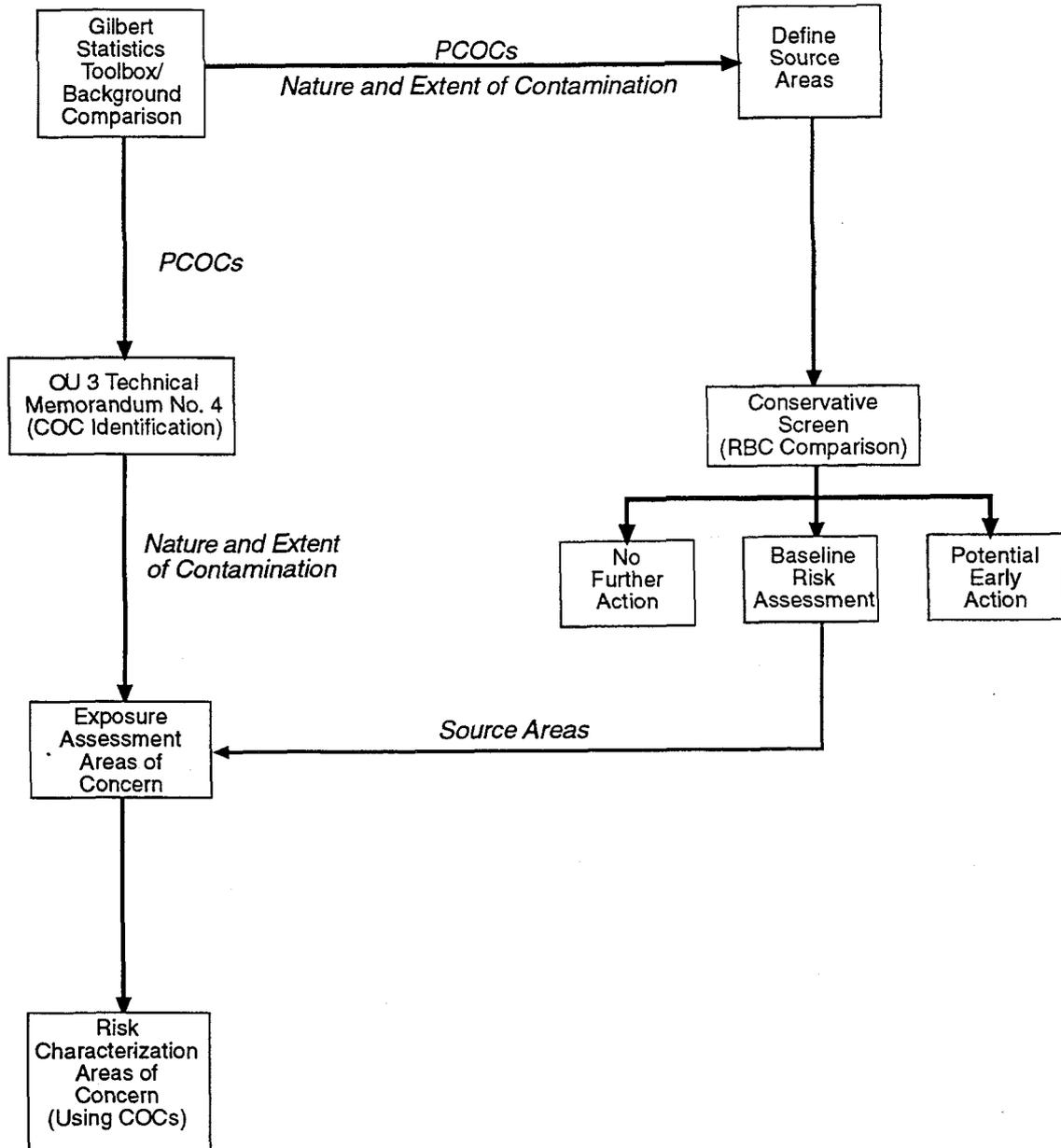
OU 3, located adjacent to the RFETS, consists of the following Individual Hazardous Substances Sites (IHSSs):

- IHSS 199: Contamination of Soils
- IHSS 200: Great Western Reservoir
- IHSS 201: Standley Lake
- IHSS 202: Mower Reservoir

This TM is a requirement set forth in the Federal Facility Agreement and Consent Order (Interagency Agreement – IAG) signed in 1991 (IAG, 1991). The RFI/RI is being conducted

## EPA COC Selection Process

## CDPHE Conservative Screen Process



CDPHE = Colorado Department of Public Health and Environment

COC = Chemicals of Concern

EPA = U.S. Environmental Protection Agency

PCOC = Potential Chemical of Concern

Source: CDPHE/EPA/DOE, 1994

**Figure 1-1**  
**COC/AREA OF CONCERN**  
**IDENTIFICATION PROCESSES**

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pursuant to the U.S. Department of Energy (DOE) Environmental Restoration Program; a Compliance Agreement between the DOE, the EPA, and the CDPHE (IAG, 1991).

The COCs are potentially site-related chemicals (i.e., potentially related to historical releases from the RFETS and subsequent migration to OU 3) whose concentrations exceed background levels and whose presence may represent a significant impact on human health. The COCs represent the chemicals that are assessed in the HHRA. COCs are identified in this TM for each medium (i.e., surface soil, sediments, surface water, and groundwater) by IHSS.

## 1.2 SCOPE

This TM focuses on selecting COCs using data for each medium sampled during the RFI/RI investigation program at OU 3, as well as other data meeting data-use guidelines (see Subsections 2.2.2 and 2.2.3 for details). The RFI/RI program was designed using the conceptual models developed as part of the OU 3 RFI/RI Work Plan (DOE, 1992). These conceptual models were developed using the information obtained in past OU 3 studies and will be updated as part of the HHRA Exposure Assessment.

As previously stated, in addition to the requirements set forth in the IAG, specific direction from the EPA, the CDPHE, and the DOE (EPA, 1989a; CDPHE/EPA, 1993; CDPHE/EPA, 1994; EPA, 1993; DOE, 1993a; DOE, 1994a; Gilbert, 1993; and EG&G, 1994) on COC selection methods was applied to the OU 3 database to establish the OU 3 COCs. This process includes an application of: 1) statistical background comparison tests; 2) a frequency of positive detection screen; 3) an essential nutrient screen; 4) a concentration-toxicity screen; and 5) a comparison to Programmatic Preliminary Remediation Goals (PRGs) (DOE, 1994b). For those media that were not assessed using the statistical background comparison tests, a weight-of-evidence evaluation (EPA, 1994) was employed to evaluate the results of these screening processes and information regarding the nature and extent of contamination within OU 3 to assess if a chemical is a COC. The specific direction also includes a process to identify source areas and areas of concern in OU 3 (referred to as the CDPHE Conservative Screen). The results of this process will be presented in a letter report and are not part of this TM.

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The COCs are selected using the OU 3 database extracted from the Rocky Flats Environmental Database System (RFEDS) as of February 15, 1994. These raw data were processed for use in the OU 3 RFI/RI and the resulting database (called the OU 3 database) is used in all subsequent RFI/RI, HHRA, and Environmental Evaluation (EE) data-analysis tasks. The data-processing protocols were applied before any analyses were performed. These protocols are described in Appendix A. Database cleanup includes removal of duplicated reports, segregation of QA/QC information, and general preparation of the data for analysis. These protocols do not include adjustment or other operations that affect or alter the analytical results.

### 1.3 SUMMARY OF COC SELECTION RESULTS

COCs were selected for each medium by IHSS by applying the specific guidance provided by the EPA, the CDPHE, and the DOE (EPA, 1989a; CDPHE/EPA, 1993; CDPHE/EPA/DOE, 1994; EPA, 1993; DOE, 1993a; DOE, 1994a; Gilbert, 1993; and EG&G, 1994a). The following chemicals have been identified as COCs for the OU 3 HHRA:

- IHSS 199 (surface soil):
  - Plutonium ( $^{239/240}\text{Pu}$ )
  - Americium ( $^{241}\text{Am}$ )
  
- IHSSs 200, 201, and 202 (sediment, surface water, and groundwater):
  - Plutonium ( $^{239/240}\text{Pu}$ ) in IHSS 200 surface sediment

The COCs will be used in the quantification of risk from exposure to chemicals and the refinement of exposure pathways (DOE, 1993b).

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## 1.4 REPORT OVERVIEW

This TM documents the preparation of the database for analysis, the steps of the COC selection process, and the results of the COC selection process. This report is divided into eight sections as follows:

- Section 1.0, Introduction
- Section 2.0, Data Preparation
- Section 3.0, Chemicals of Concern Selection Process
- Section 4.0, Chemicals of Concern in Surface Soils
- Section 5.0, Chemicals of Concern in Sediment
- Section 6.0, Chemicals of Concern in Surface Water
- Section 7.0, Chemicals of Concern in Groundwater
- Section 8.0, References

**Section 2.0, Data Preparation**, summarizes the steps used to prepare the OU 3 analytical data obtained from the RFEDS.

**Section 3.0, Chemical of Concern Selection Process**, describes the process used to select the COCs using EPA-, CDPHE-, and DOE-approved methods (EPA, 1989a; CDPHE/EPA, 1993; CDPHE/EPA/DOE, 1994; EPA, 1993; DOE, 1993a; DOE, 1994a; Gilbert, 1993; and EG&G, 1994a). This process is described in Section 3.0.

The media-specific COC selection rationale is presented in **Sections 4.0, 5.0, 6.0, and 7.0**. **Section 8.0** lists both published texts and database reference materials in separate listings. The appendices included with this TM provide supplementary information used or generated for the selection of COCs. The appendices are described below.

Documentation of the process used to create the OU 3 database is included in **Appendix A, Data Preparation**. The output generated from applying the statistical methods to surface soil data is included in **Appendix B, Background Comparison Results – SAS Output for Surface Soils**. **Appendix C, Summary Statistics**, includes descriptive summary statistics of each medium

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sampled in OU 3 before any of the steps of the screening process were applied. A summary of the results of the concentration-toxicity screen is found in **Appendix D, Concentration-Toxicity Screen Summary**. The results of the comparison of chemicals to the programmatic PRGs are included in **Appendix E, PRG Screen Comparison Results**. The remaining appendices include information regarding the application of scientific rationale for the weight-of-evidence discussion used to include or exclude a chemical as a COC. **Appendix F, Sediments and Surface Water Maps**, contains maps showing the spatial distribution of selected chemicals. An analysis of whether the distribution of a given chemical data set represents background conditions or may indicate impacted conditions is included in **Appendix G, Probability Plot Analysis**. Several guidance documents on the COC selection process are included in **Appendix H, CDPHE/DOE/EPA Guidance for the COC Selection Process**.

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## 2.0 DATA PREPARATION

This section of the TM presents a description of the database assembled for the OU 3 HHRA (the OU 3 database) – the rationale for the selection of data sets included as part of the OU 3 database and a description of the data sets comprising the OU 3 database. Also discussed are the procedures followed to create the OU 3 database from these data sets and the protocols used to identify data to be used in the COC selection process.

### 2.1 EVALUATION OF DATA SETS FOR INCLUSION INTO THE OU 3 DATABASE

Historical data for the IHSSs included in OU 3 were reviewed during development of the RFI/RI work plan. These data are summarized in the Final Past Remedy Report Operable Unit No. 3-IHSS 199 (DOE, 1991a) and in the Historical Information Summary and Preliminary Health Risk Assessment Operable Unit No. 3 – IHSS 200, 201, and 202 (DOE, 1991b). The useability of the previous data collected was reviewed in accordance with the procedures found in Guidance for Data Useability in Risk Assessment (Part A) (EPA, 1990). The conclusions indicated that much of the data do not meet data quality objectives (DQOs) to perform a rigorous quantitative risk assessment (DOE, 1992). These data may be used in the OU 3 RFI/RI nature and extent evaluations and in other data evaluations.

Based on the existing data review, a sampling program was designed to collect information necessary to perform an RFI/RI for OU 3 (DOE, 1992). The sampling was performed during 1992 and 1993 and entered into the RFEDS. Data from this sampling program are the foundation of the OU 3 database.

Two data sets from pre-RFI/RI investigations were considered for inclusion in the OU 3 database after meeting the data useability evaluation criteria (Subsection 2.2). The two data sets were: 1) the 1983/84 sediment sampling investigations data (referred to as the Setlock data in the OU 3 RFI/RI Work Plan) (DOE, 1992); and 2) the Jefferson County Remedy Acres surface soil data (DOE, 1991a). Both of these data sets were included in the OU 3 database.

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The RFI/RI work plan stated that where RFI/RI data and historical data appear to be compatible, the historical data set would undergo reevaluation to identify data that could be used quantitatively for the HHRA in conjunction with RFI/RI data.

## 2.2 OU 3 DATA

### 2.2.1 RFI/RI Sampling Program

Details of the OU 3 RFI/RI sampling program appear in RFI/RI Final Work Plan for OU 3 (DOE, 1992) and Technical Memorandum No. 1 to the Final RFI/RI Work Plan: Operable Unit No. 3 (DOE, 1993d). During the RFI/RI sampling program, the following environmental media were sampled:

- Surface soil: Sixty-one surface-soil plots were sampled to characterize the lateral extent of soil contamination. Samples were collected from each soil plot by two methods—the CDH method and the RFP method (also called the Modified Hazelton Method). The data from each method were averaged at each location and used in all data evaluations discussed in this TM. Samples were analyzed for radionuclides. A statistical analysis performed on the soil data concluded it was appropriate to combine the CDH and RFP soil data (see Attachment 4 of Appendix A).
- Subsurface soil: Eleven soil trenches were sampled at 10 depth intervals down to 96 centimeters (cm) and at each soil horizon. These data were collected to support the DOE's ongoing radionuclide-migration studies and to characterize the vertical extent of soil contamination (DOE, 1992). Samples were analyzed for radionuclides, total organic carbon, and general physical parameters.
- Surface Sediment: Grab samples were collected from 24 stream/ditch sediment locations, 46 reservoir sediment locations, and 34 nearshore sediment locations. Samples were analyzed for radionuclides, metals, cyanide, volatile organic

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compounds (Mower Reservoir only), total organic carbon, specific density, and grain size.

- Subsurface Sediment: Vertical core samples from 20 locations were collected in the reservoirs to characterize potential vertical extent of contamination (DOE, 1992); core samples were analyzed for radionuclides, metals, and cyanide.
- Surface water: Thirty-three surface-water locations (reservoir and streams/ditches) were sampled; samples were analyzed for water-quality parameters (i.e., major anions, oil and grease, silica, orthophosphate, and cyanide), metals (dissolved and total), radionuclides (dissolved and total), and organic compounds (Mower Reservoir only).
- Groundwater: Two groundwater monitoring wells were installed, one adjacent to Great Western Reservoir (IHSS 200) and one adjacent to Standley Lake (IHSS 201), to characterize potential contamination in groundwater resulting from interactions between groundwater in OU 3 and sediment and/or surface water in the OU 3 reservoirs. Samples were analyzed for metals (dissolved and total), radionuclides (dissolved and total), and water-quality parameters.
- Air: Wind-tunnel studies were conducted in OU 3, near Great Western Reservoir and Standley Lake, to measure resuspension of particulates from soil. The studies were designed to address particle size distributions relative to wind speed, and activities of suspended radionuclides by particle size (DOE, 1992). Data from these studies will be used with surface-soil data in the HHRA to evaluate exposure by the inhalation route. In addition, air-monitoring data collected through the Rocky Flats Radionuclide Ambient Air Monitoring Program (RAAMP) will be used in the HHRA to benchmark estimated ambient radionuclide activities based on the data from wind-tunnel studies.

The RFI/RI sampling locations are presented in the following figures: Figure 2-1 Soil Sample Locations; Figure 2-2 RFI/RI Sediment Sample Locations – IHSS 200; Figure 2-3 RFI/RI Sediment

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Grab Sample Locations – IHSS 201; Figure 2-4 RFI/RI Sediment Grab Sample Locations – IHSS 202; Figure 2-5 RFI/RI Surface Water and Groundwater Sample Locations – IHSS 200; Figure 2-6 RFI/RI Surface Water and Groundwater Sample Locations – IHSS 201; and Figure 2-7 RFI/RI Surface Water and Groundwater Sample Locations – IHSS 202. The locations of the two groundwater wells are shown in Figure 2-5 and Figure 2-6.

### 2.2.2 1983/84 Sediment Sampling Investigations

In 1983, a series of surficial-sediment-grab and sediment-core samples was collected from Great Western Reservoir (IHSS 200) and analyzed for  $^{239/240}\text{Pu}$ . In 1984, sediment-grab, surface-water, and sediment-core samples were collected from Standley Lake (IHSS 201) and analyzed for  $^{239/240}\text{Pu}$ . The grab sample locations for Great Western Reservoir and Standley Lake are shown in Figures 2-2 and 2-3, respectively.

As the current quality assurance (QA) requirements were not in effect at the time of the 1983/84 study, an interdata set statistical comparison was conducted as a means of evaluating the useability of the data (DOE, 1992). If the statistical tests indicated the 1983/84 data were of the same population as the OU 3 data or had higher concentrations (providing a more conservative analysis), it was proposed the data be included in the OU 3 RFI/RI report to increase the number of samples used in the data analysis work.

Data from the samples collected in 1983/84 grab sample data from Great Western Reservoir and Standley Lake were statistically compared to those from the OU 3 RFI/RI sediment grab samples collected from the respective reservoir. This statistical comparison was performed using the paired t-test and the Wilcoxon signed rank test to evaluate the appropriateness of combining the data sets for use in the COC selection process. Both statistical tests showed no significant difference at the 95 percent confidence level for  $^{239/240}\text{Pu}$  activities between the 1983/84 grab data and the OU 3 RFI/RI grab data for Standley Lake. Results indicated that both statistical tests showed a significant difference in  $^{239/240}\text{Pu}$  activities between the 1983/84 grab data and the OU 3 RFI/RI grab data for Great Western Reservoir at the 95 percent confidence level. The mean and median  $^{239/240}\text{Pu}$  activities for the 1983/84 data for Great Western Reservoir were higher than the corresponding OU 3 RFI/RI data, so combining the data

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would result in a conservative estimate of the mean activity of  $^{239/240}\text{Pu}$  in the reservoir and facilitate more robust statistical analysis. Based on the results of these statistical comparison tests and the statistical requirements identified in the work plan, the 1983/84 grab data for each reservoir were combined with the corresponding OU 3 RFI/RI data for the COC selection process and subsequent data analyses.

### 2.2.3 Jefferson County Remedy Acres Sampling Investigation

Surface-soil samples were collected in 1991 (DOE, 1991a) from two parcels of land located directly east of the eastern boundary of the RFETS. The samples were collected from tilled and untilled strips of land within the two parcels and analyzed for  $^{241}\text{Am}$ ,  $^{238}\text{Pu}$ , and  $^{239/240}\text{Pu}$ . Twenty-nine locations were sampled in the northern parcel (17 tilled strips and 12 untilled strips), and 18 locations were sampled in the southern parcel (8 tilled and 10 untilled strips). Sample locations for the northern and southern parcels of the Jefferson County Remedy Acres are shown in Figure 2-8.

The surface-soil data for the two parcels, referred to in this TM as the Jefferson County Remedy Acres data, were evaluated to determine their useability in the HHRA. Table 2-1 presents a comparison of activities of  $^{241}\text{Am}$  and  $^{239/240}\text{Pu}$  for the two data sets, Jefferson County Remedy Acres samples and RFI/RI samples. Because only a limited number of RFI/RI samples (4 out of 61 samples) were analyzed for  $^{238}\text{Pu}$ , data for  $^{238}\text{Pu}$  are not included in Table 2-1. The maximum activities for both radionuclides were greater in the Jefferson County Remedy Acres data set than either of the RFI/RI data groupings shown in Table 2-1. The decision was made to include the Jefferson County Sampling Area data in the OU 3 database because the data provide additional information for characterizing the section of OU 3 located adjacent to the RFETS boundary; also, combining the data would result in a conservative estimate of average risk for that section of OU 3. The Jefferson County Remedy Acres data also provide an assessment of the area within the OU 3 with the most significant contamination.

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TABLE 2-1  
 COMPARISON OF RFI/RI AND JEFFERSON COUNTY REMEDY ACRES  
 SURFACE SOIL DATA

Data Grouping	<sup>241</sup> Am (pCi/g)		<sup>238/240</sup> Pu (pCi/g)	
	Range	Mean	Range	Mean
RFI/RI sample plots - vicinity of Remedy Acres (PT14192, PT14292, PT15192) (n = 3)	0.013 to 0.52	0.20	0.28 to 2.95	1.33
All RFI/RI sample plots except PT14192, PT14292, and PT15192 (n = 58)	-0.002 to 0.17	0.025	0.0075 to 0.74	0.098
Remedy Acres (n = 47)	0.034 to 0.65	0.15	0.12 to 6.47	0.89

Remedy Acres = Jefferson County Remedy Acres Sampling Investigation tilled and untilled surface soil samples collected in 1991.  
 RFI/RI = RCRA Facility Investigation/Remedial Investigation surface soil samples collected in 1992.  
 pCi/g = picocuries per gram.

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## 2.3 BACKGROUND DATA

Site-specific background data are available for surface soil, stream sediments, surface water, and groundwater from the following sources:

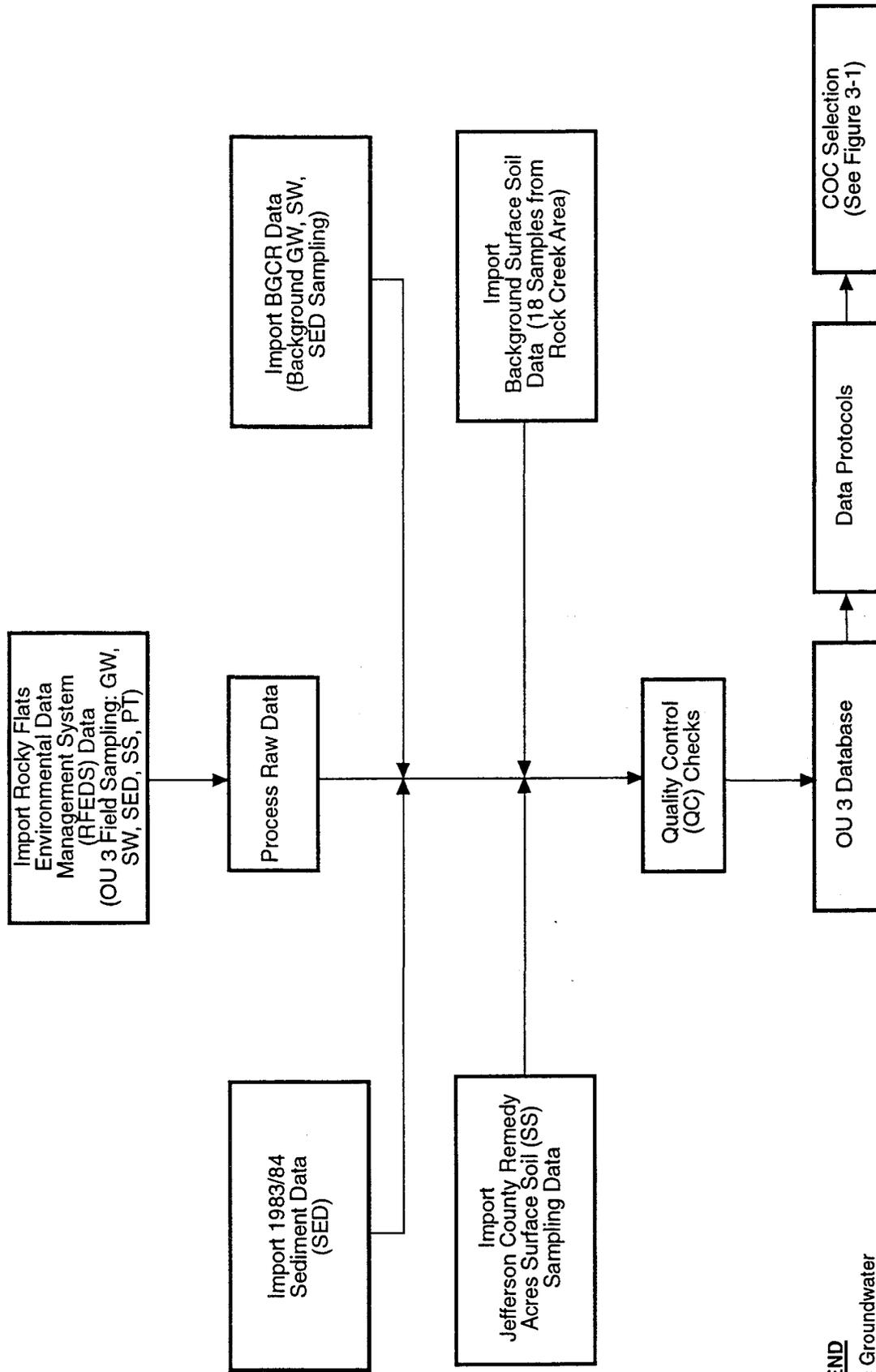
- Rock Creek Background Soil Samples (surface soil) (DOE, 1993e)
- Background Geochemical Characterization Report (surface sediments and surface water collected from streams, and groundwater) (DOE, 1993c)

These data sets include results from samples collected at stations located in buffer zone areas west, north, and south of the RFETS industrial area (DOE, 1993c). These buffer areas are near the RFETS and have to remain undisturbed by plant operations. Therefore, results of the analyses for these samples represent "background" conditions for RFETS. No samples were collected from surface sediments, surface water, or subsurface sediments in background reservoirs or lakes in areas near the RFETS.

Data quality has been evaluated as part of the above reports; therefore, a separate evaluation was not necessary.

## 2.4 OU 3 DATABASE

The OU 3 database is formatted as a set of independent Paradox (DOS Version 4.0 RDMS) tables containing fields of data. Tables were created for data sets from each of the sources described in Subsection 2.2 and Subsection 2.3. These tables can be linked through key fields (i.e., selected fields that are common to two or more tables). Figure 2-9 shows the sources of data and the general procedures that were followed to develop the OU 3 database. The last extraction of data from RFEDS used in the COC selection process was received on February 15, 1994. Appendix A contains descriptions of the tables and fields of data, as well as a detailed discussion of the procedures used to develop the OU 3 database.



**LEGEND**

- GW = Groundwater
- SW = Surface Water
- SED = Sediments
- PT = Pit Trench Soil
- SS = Surface Soil

BGCR = Background Geochemical Characterization Report (DOE, 1993c)

**Figure 2-9**  
**OU 3 DATABASE PREPARATION**

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OU 3 data are also contained in ARC/INFO files to be used for producing Geographical Information System (GIS) plots of sample locations and analytical results for sample locations for the RFI/RI report.

## 2.5 DATA USEABILITY CLASSIFICATION

Data useability levels for data used in the COC selection process were determined by the validation codes assigned to each data record by the independent data validators. Any data records that contain an "R" (i.e., rejected by the independent validators) in the validation code field were considered unusable in the COC selection process according to data useability guidance for the Environmental Restoration Program at the RFETS (DOE, 1994c; EPA, 1989a; EPA, 1990). All other data were considered acceptable for use in the COC selection process. Ninety-five percent of the validated data for surface soil, sediment, surface water, and groundwater (a total of 14,690 data records) were classified as useable. Table 2-2 summarizes the results of the data validation process by environmental medium and analytical test group.

Any nonvalidated data in the OU 3 database were assumed to be useable and therefore were included in the data set for the COC selection process. Seven percent (1,082 data records) of the surface soil, sediment, surface water, and groundwater data used in the COC selection process were not validated as of February 15, 1994. Data validation will be complete for the final RFI/RI report as currently scheduled.

## 2.6 DATA EVALUATION PROTOCOLS

Data evaluation protocols were developed based on Guidance for Data Useability in Risk Assessments (EPA, 1990) and a guidance memorandum from EG&G (EG&G, 1994b). As discussed in the previous section, the protocols were designed to identify and eliminate data considered unusable for quantitative data analysis. Additionally, the protocols provide for consistent treatment of nondetects, QC samples, and other specific categories of data in the quantitative data analyses. A Data Analysis database table was created as part of the OU 3 database for use in quantitative data-analysis tasks, including selection of COCs and other RI data analysis tasks, that reflects application of the data-evaluation protocols. The data-

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TABLE 2-2  
 DATA VALIDATION SUMMARY

Medium Analytical Test Group	Total Number of Records in Database	Number of Validated Records in Database	Number of R-Validated Records in Database <sup>a</sup>
<b>Surface Soil</b>			
Radionuclides	658	568 (86%)	31 (5%)
<b>Total</b>	<b>658</b>	<b>568 (86%)</b>	<b>31 (5%)</b>
<b>Sediment<sup>b</sup></b>			
Metals	6,405	6,208	302
Radionuclides	1,937	1,855	121
Volatile Organic Compounds	616	578	227
Physical Parameters	241	162	18
<b>Total</b>	<b>9,199</b>	<b>8,803 (96%)</b>	<b>668 (8%)</b>
<b>Surface Water</b>			
Dissolved Metals	1,362	1,177	11
Dissolved Radionuclides	323	323	45
<b>Total Metals</b>	<b>1,522</b>	<b>1,488</b>	<b>12</b>
Total Radionuclides	395	394	55
Pesticides	126	104	0
Volatile Organic Compounds	340	340	10
Water Quality	708	652	3
<b>Total</b>	<b>4,776</b>	<b>4,478 (94%)</b>	<b>136 (3%)</b>
<b>Groundwater</b>			
Dissolved Metals	464	348	6
Dissolved Radionuclides	41	35	0
<b>Total Metals</b>	<b>464</b>	<b>348</b>	<b>3</b>
Total Radionuclides	42	30	0
Water Quality	128	80	0
<b>Total</b>	<b>1,139</b>	<b>841 (74%)</b>	<b>9 (1%)</b>
<b>Total - All parameters and all media</b>	<b>15,772</b>	<b>14,690 (93%)</b>	<b>844 (5%)</b>

<sup>a</sup>R-Validated = Rejected by data validation process.

<sup>b</sup>Sediment numbers include grab (surface) and core (subsurface) data.  
 Source: OU3 Database (DB081094.8b).

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evaluation protocols and the procedures followed to create the Data Analysis table are described in detail in Appendix A.

## 2.7 ASSESSMENT OF WATER-QUALITY AND PHYSICAL PARAMETERS

The analyses for sediment, surface-water, and groundwater samples included analytes classified as water-quality parameters. The water-quality parameters include major anions found in natural waters, and general physical properties such as total suspended solids for surface water and groundwater, and total organic carbon (TOC) for sediment (Table 2-3). In general, these parameters are not associated with adverse human health effects and therefore were not included in the COC selection process. Results of these analyses are used to provide information for the evaluation of the nature and extent of contamination and the EE.

## 2.8 DATA SETS USED IN THE OU 3 COC SELECTION PROCESS

Data collected during the OU 3 RFI/RI field investigation program were prepared for quantitative data-analysis tasks, including the COC selection process, following standard data-treatment protocols. A detailed description of the preparation process is included earlier in this section and Appendix A. In addition, surface soil data from the Jefferson County Remedy Acres (DOE, 1991a) and sediment data from the 1983/84 Sediment Investigations in Great Western Reservoir (IHSS 200) and Standley Lake (IHSS 201) (DOE, 1991b) were used in the CDPHE Conservative Screen.

The data sets used in the COC selection process were selected based on an evaluation of the potential exposure pathways for OU 3 in the OU 3 RFI Work Plan (DOE, 1992). (Note: Results of further evaluation of the exposure pathways and scenarios for each IHSS of OU 3 are presented in Technical Memorandum No. 2, Human Health Risk Assessment Exposure Scenarios, Operable Unit No. 3, Rocky Flats Plant [DOE, 1993b], a draft document that is

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**TABLE 2-3**  
**WATER QUALITY PARAMETERS NOT INCLUDED\***  
**IN COC SELECTION PROCESS**

Sample Type <sup>b</sup>	Chemical Name
Sediments	Percent Solids
Sediments	Alkalinity as CaCO <sub>3</sub>
Sediments	Bicarbonate as CaCO <sub>3</sub>
Sediments	Carbonate as CaCO <sub>3</sub>
Sediments	Nitrate/Nitrite
Sediments	Nitrite
Sediments	pH
Sediments	Total Alkalinity
Sediments	Total Organic Carbon
Surface Water	Ammonia
Surface Water	Bicarbonate as CaCO <sub>3</sub>
Surface Water	Carbonate as CaCO <sub>3</sub>
Surface Water	Chloride
Surface Water	Fluoride
Surface Water	Nitrate/Nitrite
Surface Water	Nitrite
Surface Water	Oil and Grease
Surface Water	Orthophosphate
Surface Water	Phosphorus
Surface Water	Sulfate
Surface Water	Sulfide
Surface Water	Total Dissolved Solids
Surface Water	Total Suspended Solids
Groundwater	Alkalinity as CaCO <sub>3</sub>
Groundwater	Bicarbonate as CaCO <sub>3</sub>
Groundwater	Carbonate as CaCO <sub>3</sub>
Groundwater	Chloride
Groundwater	Fluoride
Groundwater	Nitrate/Nitrite
Groundwater	Nitrite
Groundwater	Orthophosphate
Groundwater	pH
Groundwater	Phosphorus
Groundwater	Silica
Groundwater	Sulfate
Groundwater	Total Dissolved Solids
Groundwater	Total Solids
Groundwater	Total Suspended Solids

\*Refer to the discussion of parameters not included in Subsection 2.6 of this document.

<sup>b</sup>Includes all IHSSs (200, 201, and 202).

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currently being revised as of September 23, 1994.) The following exposure scenarios were determined to be applicable for purposes of performing the COC selection process for OU 3:

- IHSS 199: Residential scenario, including ingestion of surface soil, inhalation of particulates, and external radiation exposure from surface soil.
- IHSSs 200 through 202: Residential scenario, including ingestion of surface sediments, inhalation of particulates, and external radiation exposure from surface sediments; incidental ingestion of surface water while swimming; and ingestion of groundwater. (Note: Receptors will most likely be exposed to environmental media in IHSSs 200, 201, and 202 through recreational use. However, for the COC selection process, the more conservative residential scenario was evaluated.

Because of the uncertainty regarding future use of Great Western Reservoir (IHSS 200), an additional scenario involving exposure of construction workers to subsurface sediments was determined to be applicable for IHSS 200. This exposure scenario for Great Western Reservoir (IHSS 200) assumes the reservoir will be drained for the construction of buildings or other facilities, and that a construction worker will be exposed to subsurface sediments at any depth interval as if the sediments were subsurface soil.

Subsurface sediments in Standley Lake (IHSS 201) and Mower Reservoir (IHSS 202) were not evaluated because it is unlikely either of these reservoirs will be drained in the future and, therefore, construction workers will not be exposed to subsurface sediments. Standley Lake is currently a source of drinking water and irrigation water; Mower Reservoir is privately owned and is used for agricultural purposes such as irrigation and water for livestock (DOE, 1993b). No changes in use for either Standley Lake or Mower Reservoir are expected.

COCs were not selected specifically for air because the surface soil and sediment COCs will be used in the HHRA to evaluate the inhalation (air) pathway. The HHRA will evaluate the resuspension and dispersion of soil and sediment particles in the air and subsequent exposure

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via inhalation of the particles. Additionally, the wind-tunnel results will be incorporated into the HHRA, as appropriate, when evaluating the resuspension and dispersion of particles in OU 3.

In summary, the COC selection process was applied to the following data sets:

IHSS 199, Contamination of Soils:

- Surface soils

IHSS 200, Great Western Reservoir:

- Surface sediments
- Subsurface sediments
- Surface water
- Groundwater

IHSS 201, Standley Lake:

- Surface sediments
- Surface water
- Groundwater

IHSS 202, Mower Reservoir:

- Surface sediments
- Surface water

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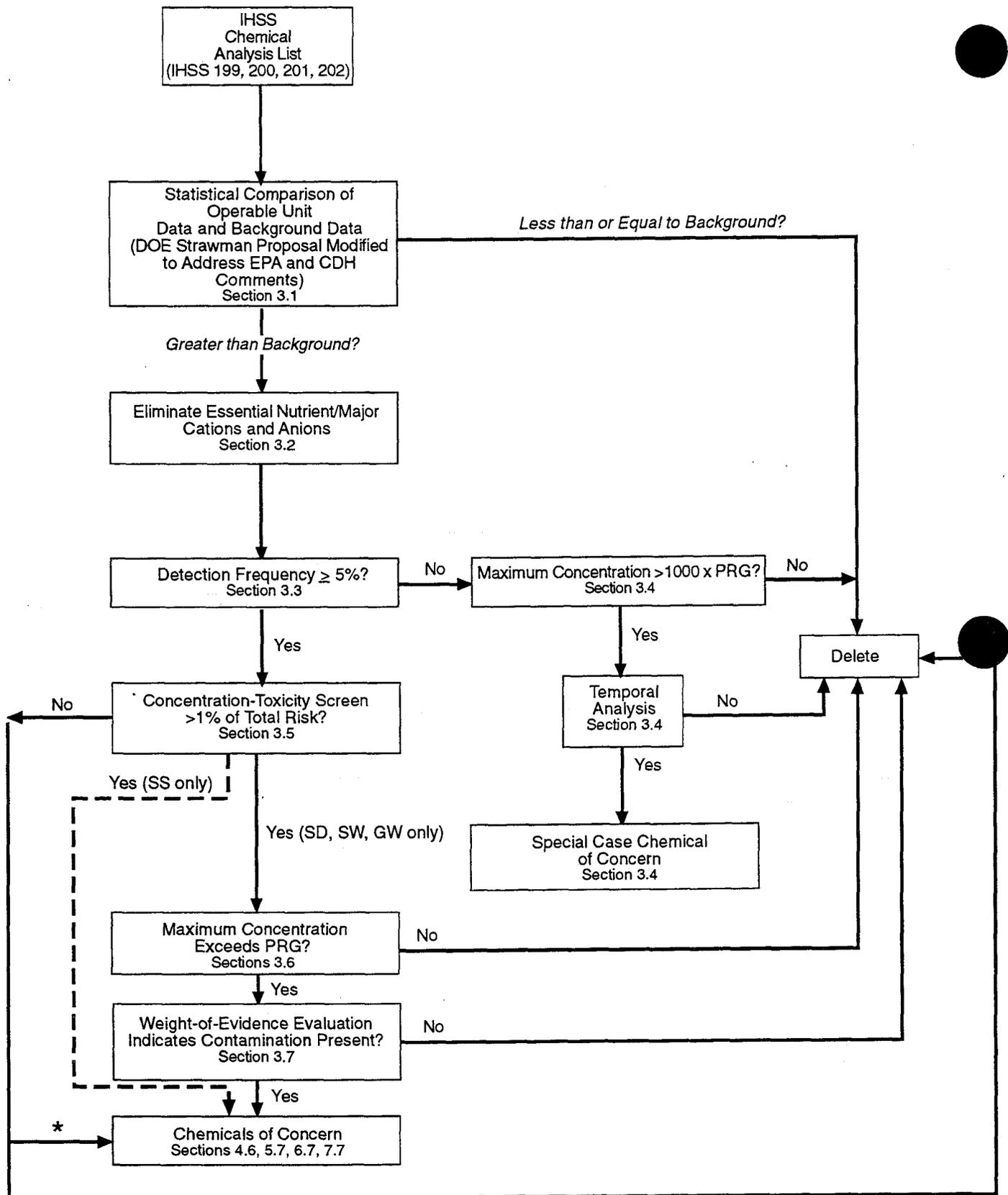
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### 3.0 CHEMICALS OF CONCERN SELECTION PROCESS

The COC selection process identifies the chemicals detected in OU 3 that contribute significant potential risks to human receptors. The objective of the process is to identify those chemicals in a particular medium that, based on concentration and toxicity, contribute significantly to risks calculated for exposure scenarios involving that medium (EPA, 1989). The COCs will be used in the HHRA for OU 3 to quantify risks associated with exposure to surface soils, stream and reservoir sediments, surface water, and groundwater. The COC selection process was agreed upon by EPA, CDPHE, and DOE and is based on Risk Assessment Guidance for Superfund (EPA, 1989), the Rocky Flats IAG between the State of Colorado (CDPHE), the EPA, and the Department of Energy, January 1991 (IAG, 1991), and site-specific guidance (CDPHE/EPA, 1993; DOE, 1993a; EPA, 1994).

The COC selection process, as specified by the EPA, CDPHE, and DOE, is outlined in Figure 3-1 and includes the following steps:

- Statistical comparison of site data to background data (Subsection 3.1)
- Elimination of essential nutrients (Subsection 3.2)
- Elimination of chemicals detected infrequently (less than 5 percent detection frequency) and less than 1,000 times a risk-based concentration (Subsections 3.3 and 3.4)
- Concentration-Toxicity screen (Subsection 3.5)
- Comparison to Preliminary Remediation Goals (PRGs) (Subsection 3.6)
- Weight-of-evidence evaluation (Subsection 3.7)



\* Professional Judgement

SS = Surface Soil  
SD = Sediments  
SW = Surface Water  
GW = Groundwater

Source: Adapted from CDPHE/EPA, 1994

**Figure 3-1**  
**HUMAN HEALTH RISK ASSESSMENT**  
**CHEMICALS OF CONCERN**  
**SELECTION PROCESS**

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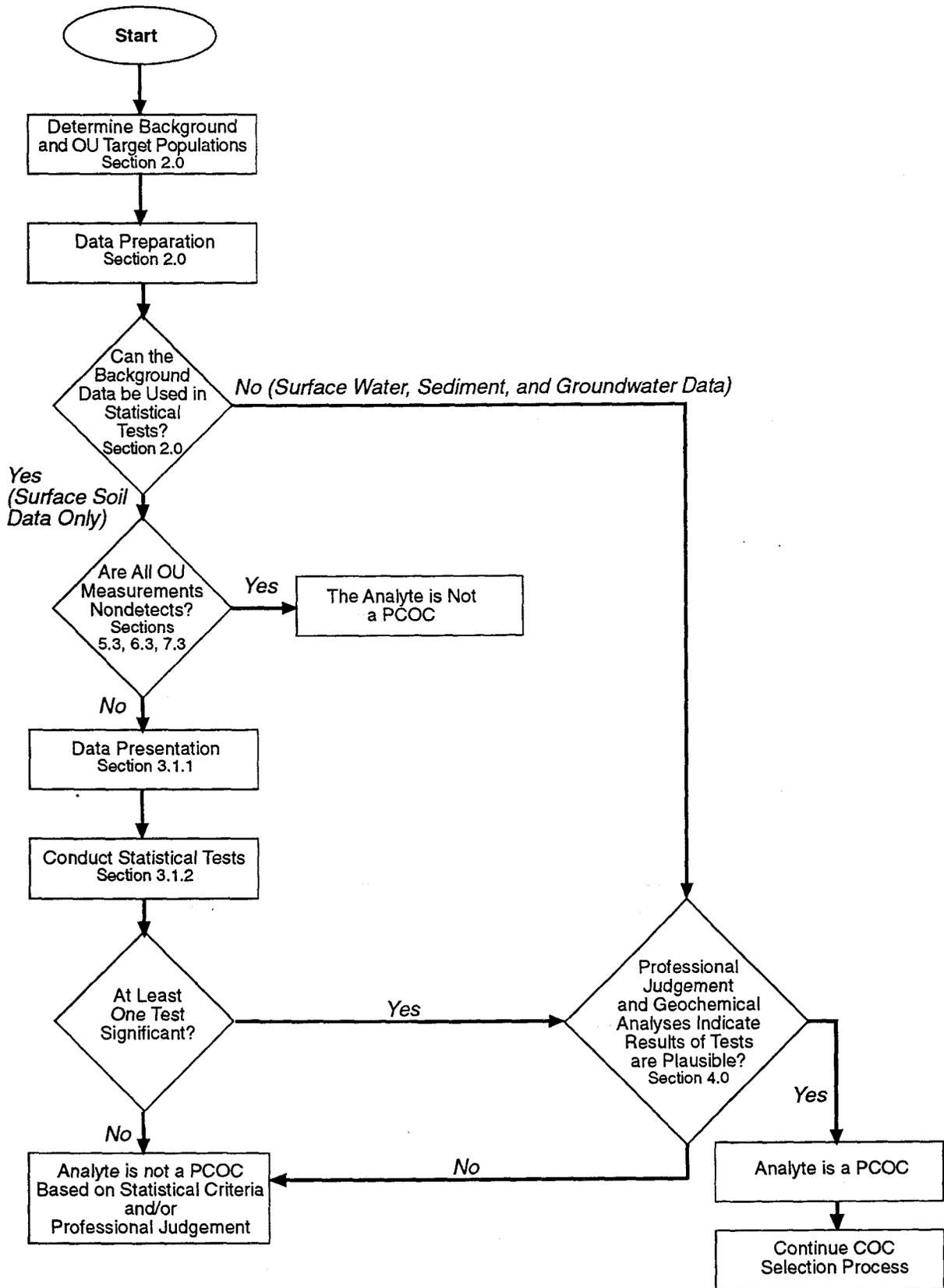
Figure 3-1 also cross-references each COC selection step to its respective section in this document. An example application of the weight-of-evidence evaluation is presented in Subsection 3.8.

### 3.1 STATISTICAL COMPARISON TO BACKGROUND

The purpose of this step of the COC selection process is to identify chemicals with concentrations/activities in OU 3 that are significantly greater than corresponding concentrations/activities in background. (Note: Activity is the unit of measure for radionuclides and concentration is the unit of measure for non-radionuclides [i.e., metals, organic compounds, etc.]). The statistical comparison methodology (Figure 3-2) includes a data-presentation step and a series of statistical comparison tests that are performed for each analyte. The statistical methodology for OU-to-background comparisons was agreed upon by EPA, CDPHE, and DOE (DOE, 1993a; EPA, 1993; DOE, 1994a; EG&G, 1994a) and is based on site-specific guidance developed by Gilbert (1993).

Statistical tests are performed only after the data have been prepared and meet requirements for statistical analysis (see Section 2.0). After evaluating the OU 3 and existing background data sets (i.e., groundwater, sediment, and surface-water background data in Background Geochemical Characterization Report [BGCR] [DOE, 1993c] and Rock Creek surface-soil background data [DOE, 1993e]), the statistical comparison methodology was only used for OU 3 surface-soil data. The evaluation is described in the following paragraphs.

The comparability of data sets for statistical comparisons is important for reliable statistical findings (Gilbert, 1993). The background data sets in the BGCR (DOE, 1993c) for sediment, surface water, and groundwater were not considered appropriate for rigorous statistical comparison tests. OU 3 and background data sets for sediments and surface water represent different environmental conditions and flow regimes. The majority of OU 3 samples for surface water and sediment were collected from reservoirs, and the BGCR data for sediment and surface water were collected from streams. Too few samples were collected in the streams in each IHSS (eight total samples for all three IHSSs combined) to perform a valid statistical



**Figure 3-2**  
**FLOWCHART FOR COMPARING OU**  
**DATA TO BACKGROUND**

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analysis on an IHSS-by-IHSS basis. The power of the statistical tests decreases dramatically with less than eight data points (Gilbert, 1987).

While the background groundwater data set is composed of data collected from 49 wells (157 total samples), the OU 3 groundwater data were obtained from only 2 wells (sampled eight times each). Rigorous statistical comparisons would not be valid when comparing the results of 2 wells to 49 wells. In addition, the wells designated as background represent different environmental conditions and groundwater flow regimes.

The term "background data" is used to represent the data collected and summarized in the BGCR (DOE, 1993c) and the Rock Creek surface soil data used in the statistical comparison tests. An example of a statistical comparison using background data is the comparison between the OU 3 surface soil data set and the Rock Creek surface soil data set. The term "benchmark data" is used to differentiate between background data sets appropriate for statistical comparison and background data taken from published literature. Benchmark data sets gleaned from published literature (described in Subsection 3.7.1) provide sediment, surface water, and groundwater data sets for comparison to OU 3 data. These benchmark data were not considered appropriate for quantitative statistical comparisons because of small sample size and limited information about sampling and analytical methods and data quality. Thus, the first step of the COC selection process for sediment, surface water, and groundwater begins with the Essential Nutrients screen in place of the statistical comparison tests.

Sixty-one RFI/RI surface-soil samples and 47 Jefferson County Remedy acres soil samples were compared to 18 Rock Creek background samples. The Rock Creek sampling sites are located in the northwest corner of the Rocky Flats buffer zone (Figure 3-3).

An example of a benchmark data set is data from the Cherry Creek Basin Authority (CCBA, 1994), which includes mean concentrations for metals in Cherry Creek Reservoir sediments. A description of the benchmark data is found in Subsection 3.8.

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### 3.1.1 Data Presentation

The data-presentation step, as recommended by Gilbert (1993), is used to enhance the understanding and interpretation of the statistical tests; it graphically displays the background and OU 3 data sets and compares the magnitude, variability, and degree of their overlap. Several graphical data-presentation techniques were used to display the background and OU 3 data, including histograms, box plots, and probability plots. Results of the data-presentation step for surface soil are included as Appendix B and are discussed in Section 4.0.

### 3.1.2 Statistical Tests

Five statistical tests were performed for the surface-soil data for each analyte (Figure 3-4):

1. Hot-Measurement test
2. Gehan test
3. Quantile test
4. Slippage test
5. t-test

If any one of the statistical tests performed for a given comparison indicated a significant difference between OU 3 and background data, then the analyte was considered to be a Potential Chemical of Concern (PCOC) and professional judgement was applied to determine if the statistical results were plausible (Gilbert, 1993). Each of these statistical tests is based on different statistical hypotheses and assumptions. The purpose and method of each statistical test are briefly described in the following subsections. The hypothesis tested, test description, and assumptions made for each statistical test are described in detail. Results of the statistical comparison tests are presented in Appendix B.

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nondetects. When there are no nondetects, the Gehan test is identical to the WRS test. The test is a nonparametric test and, as such, can be used regardless of the distribution of the data.

If the OU 3 data are significantly different from background data under the Gehan test, then the analyte is considered to be a PCOC, pending further investigation. All analytes are carried through the remaining tests.

### 3.1.2.3 Quantile Test

The quantile test is a nonparametric test and can be used regardless of the distribution of the data and where multiple detection limits are present. The hypothesis tested is whether the 80th percentiles of the two data sets are statistically significantly different from each other with 95 percent confidence.

The quantile test is very similar to the slippage test and is considered to be a rapid screening test. The quantile test is more powerful than the slippage test when the magnitude of differences is not large. It is more powerful than the WRS test when analyte concentrations in a small proportion of the OU are highly contaminated.

The test is performed by first listing the combined background and OU 3 measurements from smallest to largest. The number of measurements from the OU 3 data among the top 20 percent of the measurements of the combined data sets are counted. If this number is greater than or equal to a predetermined value, then the analyte is considered to be a PCOC, pending further investigation. As shown in Figure 3-4, in order for this statistical test to be applicable, the top 20 percent of the combined data sets must be detects.

### 3.1.2.4 Slippage Test

The slippage test is also a nonparametric test. To perform the test, the number of OU 3 measurements that exceed the maximum background value are counted. This number is compared to a critical value at 95 percent confidence obtained from a table. If the number

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exceeds the critical value, then the analyte is considered to be a PCOC, pending further investigation. The largest background value can be a detect or nondetect and the slippage test is applied to all comparisons. If the maximum value is a nondetect, then the detection limit is used as the maximum value. This test has good power (the ability to detect significant differences between OU 3 and background concentrations/activities) to detect when a fairly large proportion of the OU has analyte concentrations substantially greater than the maximum background measurement.

#### **3.1.2.5 t-Test**

The t-test is a parametric test and determines whether the means of two populations are statistically significantly different at 95 percent confidence. The t-test is the most powerful test for detecting a difference in the two populations where the background and OU 3 data are normally distributed and independent and both data sets have less than 20 percent nondetects. The distributions of the data sets are tested using the Shapiro-Wilk test for normality. If both the background and OU data contain at least 20 data points, and the means of the data sets are approximately normally distributed, then the t-test is performed.

If the OU 3 data are significantly different from background under the t-test, then the analyte is considered to be a PCOC, pending further investigation.

#### **3.1.3 *Professional Judgement***

The background-comparison methodology, as developed by Gilbert (1993), emphasizes the step of evaluating the output of all statistical tests using professional judgement to determine if the results of the tests indicate contamination at the OU. Specific guidance from EPA and CDPHE (EPA/CDPHE, 1993) limits this step to the following types of data evaluations:

- Spatial distribution – tools such as spatial plots and compound-specific mobility considerations

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- Temporal distribution – tools such as time-series plots
- Pattern-recognition concepts – tools useful in identifying anomalies as well as confirming "fingerprint" associations.

These professional judgement steps will be applied only to surface soil data sets after the statistical tests are performed.

### 3.2 ESSENTIAL NUTRIENTS

The following inorganics were eliminated from all environmental media by this step of the COC selection process:

- Calcium
- Iron
- Magnesium
- Potassium
- Sodium

These nutrients are eliminated because they are considered an essential element in the diet (EPA, 1989a).

### 3.3 DETECTION FREQUENCY

Chemicals that are infrequently detected may be artifacts in the data because of sampling or analytical problems and therefore may not be site-related (EPA, 1989a). Detection frequencies for each chemical not eliminated by the first two steps of the COC selection process were evaluated by medium and IHSS. Chemicals that were not detected in any samples within a medium and IHSS were eliminated as COCs for that medium and IHSS. Chemicals detected in less than 5 percent of the samples for a medium within an IHSS were identified and further evaluated as described in Subsection 3.4.

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### 3.4 RBC COMPARISON

Each chemical that had a detection frequency between zero and 5 percent was further evaluated to determine if the samples with results above detection limits represent potential areas of localized contamination. For this step, the maximum detected value for each chemical was compared to a Risk-Based Concentration (RBC). (RBCs are the same as PRGs, but the term PRG will be used for the remainder of this document.) The PRGs used in this step are based on a residential exposure scenario for surface soil, sediment, and groundwater and were calculated based on the methodology presented in Programmatic Preliminary Remediation Goals (DOE, 1994b). For surface water, the PRGs are based on a recreational exposure scenario because any exposure to unfiltered surface water is assumed to occur through recreational use of the reservoirs. If the maximum detected value did not exceed 1,000 times the PRG, the chemical was eliminated as a COC. No chemicals in the OU 3 database (regardless of detection frequency) were found at levels 1,000 times the PRG. Thus, temporal analysis was not performed on any analyte and there are no special-case COCs for OU 3.

Chemicals without oral and inhalation toxicity values cannot be evaluated in the PRG screen. These chemicals were evaluated in the weight-of-evidence evaluation described in Subsection 3.7.

### 3.5 CONCENTRATION-TOXICITY SCREEN

The concentration-toxicity screen is used to identify the chemicals within each medium and IHSS that are most likely to contribute significantly to risks (99 percent) calculated for exposure scenarios involving the medium and IHSS. The concentration-toxicity screen was performed following EPA guidance (EPA, 1989a). The first part of the screen was to calculate an individual risk factor for each chemical not eliminated by previous steps in the COC selection process. The chemical risk factor was calculated either by multiplying the maximum chemical concentration by the corresponding slope factor for carcinogens, or by dividing the maximum chemical concentration by the corresponding reference dose (RfD) for chemicals with noncarcinogenic effects. For chemicals with both oral and inhalation toxicity values, the more

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conservative toxicity factors (i.e., greater slope factor for carcinogens and lower RfD for chemicals with noncarcinogenic effects) were used to calculate the chemical risk factors.

The individual risk factors were then summed by medium and IHSS to obtain a total risk factor, according to the end point of toxicity (carcinogenic or noncarcinogenic effects). Radionuclide and nonradionuclide chemicals were summed separately because units for slope factors and concentrations/activities in environmental media are different for these two classes of chemicals. The ratio of each individual chemical risk factor to the total risk factor approximates the relative risk for that medium and IHSS due to each chemical. The chemicals whose combined ratios sum to 0.99 (99 percent) of the total risk were considered likely to contribute significantly to the overall risk. All other chemicals were eliminated as COCs.

Chemicals without oral or inhalation toxicity values cannot be evaluated in the concentration-toxicity screen step. The chemicals without toxicity values that were detected in OU 3 were evaluated further using a weight-of-evidence evaluation to determine if levels of the chemicals in OU 3 were elevated over background conditions. The results of this evaluation are included in the discussions of the weight-of-evidence evaluation in Subsections 5.6, 6.6, and 7.6 for sediment, surface water, and groundwater, respectively.

### 3.6 PRG SCREEN

The chemicals remaining at this point in the COC selection process were evaluated further using the PRG screen. The PRGs were calculated based on the methodology presented in Programmatic Preliminary Remediation Goals (DOE, 1994b) and included in Attachment 1 of Appendix E. The maximum detected values for the chemicals whose combined risk factor ratios summed to 0.99 for each medium and IHSS in the concentration-toxicity screen were compared to their corresponding PRGs. Any chemicals with maximum detected values less than the corresponding PRG were eliminated as COCs. Maximum detected values greater than a PRG were carried through the weight-of-evidence evaluation described in Subsection 3.7.

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The results of the PRG screen for sediment, surface water, and groundwater are included in Appendix E.

### 3.7 WEIGHT-OF-EVIDENCE EVALUATION

As discussed in Subsection 3.1, statistical background comparison tests were performed only for surface soil because site and background data sets for the other media were not considered comparable for the purposes of rigorous quantitative, statistical tests. Consequently, an alternative approach for comparing site to background data was used for sediment, surface water, and groundwater (EPA, 1994). The alternative approach is referred to as the "weight-of-evidence evaluation" because it relies on a series of evaluations. The weight-of-evidence evaluation involves the application of a variety of data analysis techniques in lieu of a rigorous, quantitative statistical testing scheme as proposed by Gilbert (1993). The results of the evaluations are considered together to assess if levels of chemicals detected in OU 3 represent background conditions or contamination. The weight-of-evidence evaluation also serves as the nature-and-extent-of-contamination evaluation defined in the CDPHE/EPA/DOE COC selection process and the CDPHE Conservation Screen (CDPHE/EPA/DOE, 1994).

The following analyses are included in the weight-of-evidence evaluation (Figure 3-5):

- Comparisons of means, standard deviations, and ranges of OU 3 data to BGCR (DOE, 1993c) data (background sample locations for sediment, surface water, and groundwater are shown in Figure 3-4)
- Comparisons of means, standard deviations, and ranges of OU 3 data to benchmark data (see Subsection 3.8)
- Probability plot analysis evaluating data populations
- Temporal analysis of data to identify seasonal variations or sampling anomalies

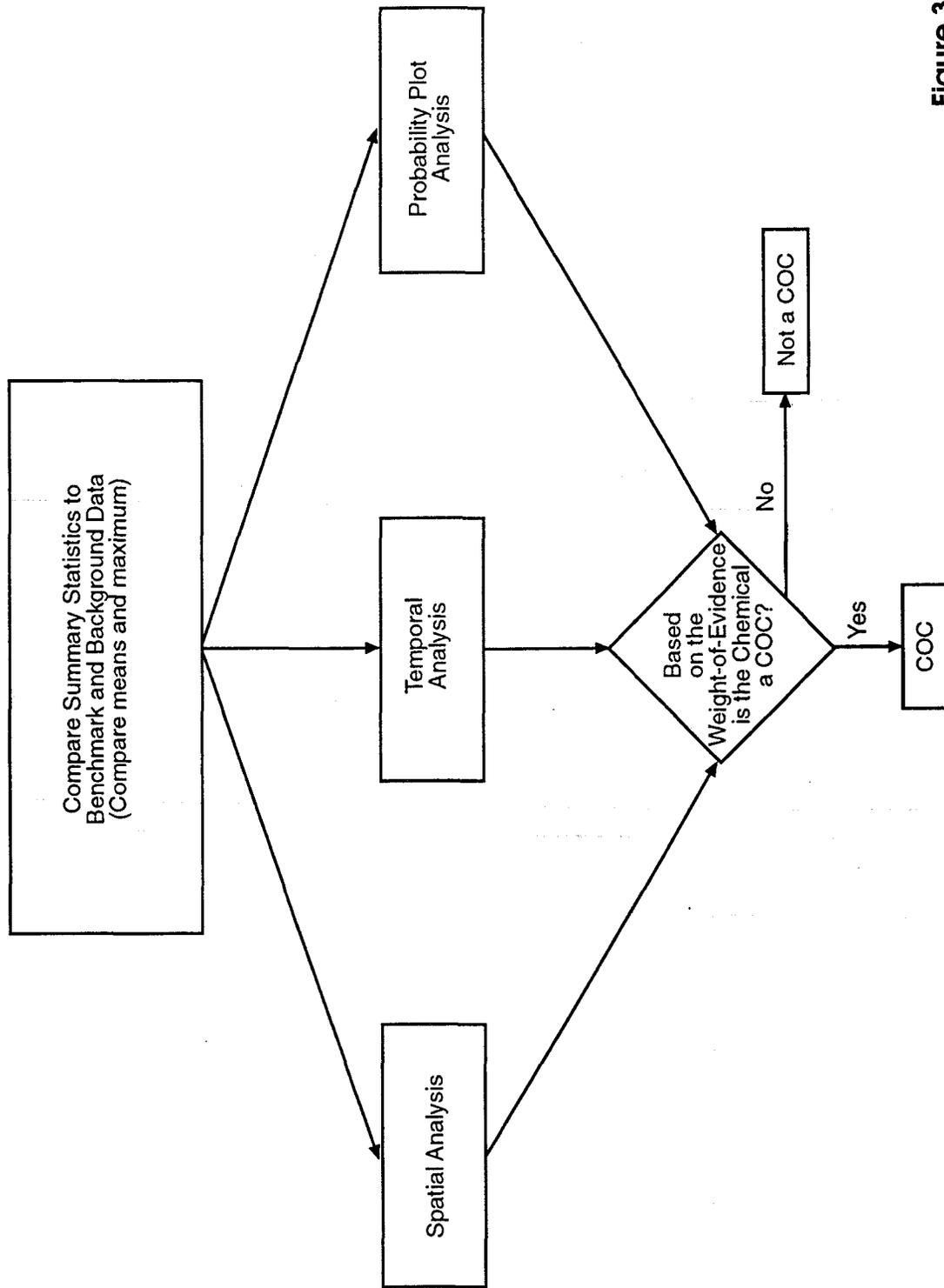


Figure 3-5  
WEIGHT-OF-EVIDENCE EVALUATION

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- Spatial analysis combined with the evaluation of physical processes affecting deposition and the evaluation of contribution of various water sources to OU 3 reservoirs

Each of these evaluations was performed as appropriate for each environmental medium within an IHSS. The results of the evaluations were considered together to assess if a chemical was retained as a COC. For those chemicals eliminated as COCs by this step, convincing evidence supported the conclusion that detected levels of the chemical in OU 3 are representative of background conditions. The benchmark data collection activities are described in Subsection 3.8.

An example of the weight-of-evidence evaluation for arsenic in sediments is provided in Subsection 3.9.

### **3.8 BENCHMARK DATA COLLECTION ACTIVITIES**

A search was performed to gather benchmark literature data for the comparison of OU 3 sediment and surface-water data. More than 20 sources were contacted to obtain benchmark data for sediments and surface water, as shown in Table 3-1. The data-gathering effort focused on obtaining reservoir and lake data in the Front Range and Colorado. The term "benchmark data" is used in this TM to represent the data compiled from literature and other data sources referenced in Table 3-1 to represent background conditions within the Front Range and Colorado. Benchmark data differs from background data sets, which are appropriate for statistical comparison. The term "background data" is used to represent the data collected and summarized in the Background Geochemical Characterization Report (DOE, 1993c) and the Rock Creek surface soil data. Data from the Background Geochemical Characterization Report were used to make comparisons to OU 3 data in the weight-of-evidence evaluation. The Rock Creek soil data were used in the statistical comparison tests.

The benchmark data that was primarily used for sediment comparisons include four lakes in the Rocky Mountain National Park: Lake Husted, Lake Louise, Lake Haiyaha, and the Loch (Heit,

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TABLE 3-1  
 FRONT RANGE SOURCES CONTACTED AS PART OF BENCHMARK DATA COLLECTION ACTIVITIES

Source	Media	Parameter(s)
Aurora Reservoir Water Quality Control	Surface Water	Metals
Arvada Department of Water and Environmental Quality	Surface Water	Metals
Background Geochemical Characterization Report	Surface Water	Metals/Radionuclides
Bear Creek Water and Sanitation District	Surface Water	Metals/Radionuclides
Boulder Department of Water and Environmental Quality	N/A	N/A
Broomfield Department of Water and Environmental Quality	N/A	N/A
Chatfield Basin Authority	Surface Water	Metals
Cherry Creek Basin Authority	Surface Water/Sediment	Metals
Colorado School of Mines	Sediment	Radionuclides
Coors Brewing Company	N/A	N/A
Denver Regional Council of Governments	Surface Water/Sediment	Metals/Radionuclides
Final Historical Information Summary and Preliminary Health Risk Assessment OU 3 (DOE, 1991b)	Sediment	Radionuclides
Interim Baseline Risk Assessment for the Sharon Steel/Midvale Tailings Site	N/A	N/A
Jefferson County Health Department	N/A	N/A
Last Chance Dam and Reservoir - Preliminary Feasibility Study	Soils	Metals
Rocky Flats Program Unit	N/A	N/A
Rocky Flats Reading Room	Surface Water	Radionuclides
Superfund Records Center	Surface Water/Sediment/Soils	Metals
U.S. Army Corps of Engineers	Surface Water/Sediment	Metals/Radionuclides
U.S. Geological Survey Library	N/A	N/A
U.S. Geological Survey Water Resources Division	N/A	N/A
University of Colorado at Boulder	N/A	N/A
Water Quality Control Division - STORET (EPA, 1993DB and 1994DB)	N/A	N/A
Westminster Department of Water and Environmental Quality	Surface Water	Metals
	N/A	N/A

N/A = No available data.

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et al., 1984). Sediment data were also available from Cherry Creek Reservoir (DRCOG, 1994). In addition, background sediment stream data from the Lowry Landfill Superfund site was also used (EPA, 1992).

The primary data sets identified during the benchmark data collection activities for surface water included Ralston Creek, Croke Canal, and Farmer's Highline Canal (Arvada, 1994DB). The reservoir data were compared to Chatfield Reservoir, Cherry Creek Reservoir, Bear Creek Lake, and Harriman Lake (Arvada, 1994DB; EPA, 1993DB and 1994DB).

During the benchmark data-collection activities, information was also collected from lakes outside of Colorado for comparative purposes. Data from Superfund sites and other impacted areas were also collected. The purpose of using information from contaminated sites is to place the OU 3 concentration/activity levels in perspective with other investigated sites. These data sets are presented in figures summarizing the OU 3 concentrations/activities for a given chemical in Sections 5.0 and 6.0.

### 3.9 WEIGHT-OF-EVIDENCE EXAMPLE

This subsection presents an illustration of how the weight-of-evidence evaluation was applied to arsenic measured in OU 3 surface sediments.

A summary of the analytical results for arsenic in sediments (for each IHSS) is presented in Appendix C (Tables C-3 to C-9). Appendix C shows the summary statistics (before the COC selection was performed) by IHSS, including number of detects, number of samples, frequency of detection, minimum nondetected value, maximum nondetected value, minimum detected value, maximum detected value, arithmetic mean, standard deviation, normal 95 percent upper confidence limit (UCL), and lognormal 95 UCL. The summary statistics are used to provide the analyst the makeup of the data set (i.e., the frequency of detection and magnitude of concentration) before the COC selection process is performed. The use of summary statistics is part of an exploratory analysis phase that involved using visual and graphical presentations of the data (every chemical will not be displayed visually in this TM).

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### 3.9.1 Comparison of OU 3 Data to Benchmark Data

This step involves comparing the OU 3 data to benchmark data in a less formal, quantitative manner than using the five statistical tests described in Subsection 3.1. However, this step alone cannot eliminate arsenic as a COC. The benchmark data comparison in conjunction with the other weight-of-evidence evaluations provides the rationale that arsenic is not a COC.

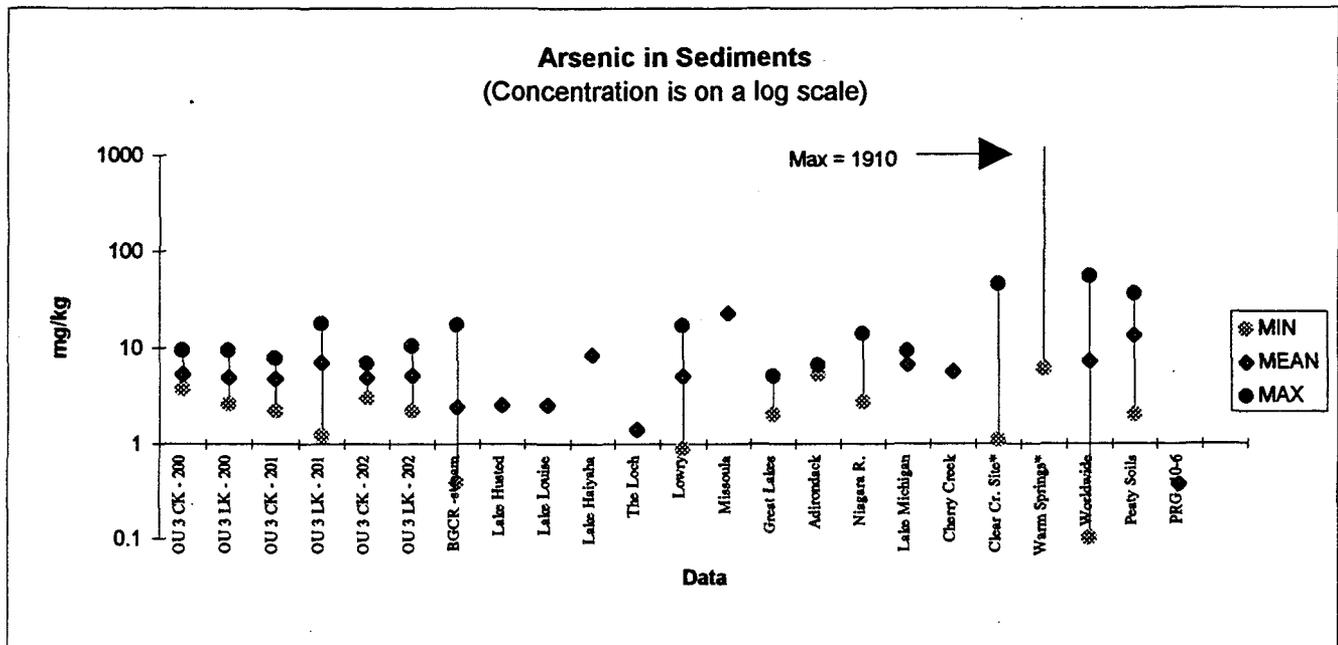
This evaluation step for arsenic involved the use of a visual data-presentation technique (Figure 3-6) where the magnitude of concentrations of the OU 3 data for streams and reservoir sediment are presented with the Rocky Flats background data for stream sediments and relevant benchmark data from the literature. The top portion of Figure 3-6 is a tabulation of these data; the bottom segment profiles the data to promote comparison of individual data points as well as ranges. The data presented in Figure 3-6 include sediment data from Superfund sites, Rocky Mountain National Park lakes, the Great Lakes, Adirondack lakes, Cherry Creek Reservoir in Colorado, Missoula Lake bed sediments, and worldwide data. The purpose of using information from contaminated sites (the Warm Springs Pond Superfund site and the Clear Creek Superfund site) in addition to nonimpacted sites is to place OU 3 levels in perspective with other investigated sites.

Figure 3-6 illustrates the following:

- The arsenic concentrations for OU 3 sediments between the IHSSs are consistent. All reported concentrations are less than 17.7 milligrams per kilogram (mg/kg) and there are no apparent spurious data that would suggest anomalous concentrations.
- The range of OU 3 arsenic concentrations in reservoirs (1.2 to 17.7 mg/kg) is comparable with the ranges of the BGCR (DOE, 1993c) data (sediments that are not impacted) – 0.39 to 17.3 mg/kg. Additionally, the OU 3 and background data are within the range, and comparable to, the expected worldwide ranges (0.1 to 55 mg/kg, mean of 7.2 mg/kg).

**ARSENIC IN SEDIMENTS**  
(mg/kg)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3 CK - 200	3.7	5.31	9.4	1.85	Great Western Reservoir (Creek) (OU 3 Database)
OU 3 LK - 200	2.6	4.91	9.4	1.46	Great Western Reservoir (Lake) (OU 3 Database)
OU 3 CK - 201	2.2	4.76	7.8	1.53	Standley Lake (Creek) (OU 3 Database)
OU 3 LK - 201	1.2	6.96	17.7	4.34	Standley Lake (Lake) (OU 3 Database)
OU 3 CK - 202	3	4.88	6.8	1.56	Mower Reservoir (Creek) (OU 3 Database)
OU 3 LK - 202	2.2	5.15	10.4	1.96	Mower Reservoir (Lake) (OU 3 Database)
BGCR -stream	0.39	2.4	17.3	2.45	RFP Background Stream Sediments, BGCR (DOE, 1993c)
Lake Husted		2.5		0.2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lake Louise		2.5		0.3	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lake Haiyaha		8.4		0.2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
The Loch		1.4		0.2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lowry	0.9	5	17	4	Lowry Landfill Background Stream Sediment OUs 2-5 Baseline Risk Assessment (EPA, 1992)
Missoula		23			Missoula Lake Beds Surface Sediment (Moore and Ramamoorthy, 1984)
Great Lakes	2		5		Great Lakes Surface Sediment (Fergusson, 1990)
Adirondack	5.3		6.5		Lake Adirondack Surface Sediment (Fergusson, 1990)
Niagara R.	2.7		14		Niagara River Sediment (polluted) (Fergusson, 1990)
Lake Michigan		6.6	9.2		Lake Michigan Surface Sediment (Fergusson, 1990)
Cherry Creek		5.57			Cherry Creek Reservoir Surface Sediment (CCBA, 1994)
Clear Cr. Site*	1.1		46		Clear Creek Superfund Site (CDPHE, 1990)
Warm Springs	6		1910		Warm Springs Pond Superfund Site, Pond Bottom Sediments (EPA, 1988)
Worldwide	0.1	7.2	55	7.2	Worldwide Sediment (Boyle & Jonasson, 1973)
Peaty Soils	2	13.4	36	9.4	Peaty Soils (Boyle & Jonasson, 1973)
PRG-10 <sup>6</sup>		0.37			10 <sup>6</sup> PRG level based on a residential soil scenario (EG&G, 1994a)



Notes: If blank, no data are available.

\*Indicates Superfund site.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 3-6**  
**EXAMPLE DATA COMPARISON—ARSENIC IN SEDIMENTS**

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- The profile of the OU 3 mean concentrations of arsenic in OU 3 sediments (4.76 to 6.96 mg/kg) shows concentrations comparable to ranges of Lowry Landfill Superfund site stream sediments that are assumed not to be impacted (0.9 to 17 mg/kg).
- Both the OU 3 data and the benchmark data are distinguishable from these data representing arsenic contamination (e.g., Warm Springs Pond, Clear Creek). Arsenic concentrations in OU 3 are not within the upper end of the ranges of heavily polluted sites (Warm Springs Pond and Clear Creek). The maximum arsenic concentration in OU 3 sediments ranges from 6.8 mg/kg to 17.7 mg/kg, compared with 46 mg/kg at the Clear Creek Superfund site (CDPHE, 1990) and 1,910 mg/kg at the Warm Springs Pond Superfund site (EPA, 1988).

### 3.9.2 Temporal Analysis

OU 3 analytical data were also evaluated over time (if sufficient data collected over time were available) to discern any anomalous trend or pattern. Concentration levels sharply elevated at one point in time may indicate a historical release event contributing to concentrations above background. Sediment core profiles were analyzed for some analytes to evaluate if possible patterns existed throughout the sediment layer. Analyte profiles with discernible peaks may indicate source discharges from the RFETS.

Arsenic concentrations in sediment core profiles did not show any consistent peaks or patterns (Figure 3-7). The concentrations of arsenic in the sediment core samples range from 3.6 mg/kg to 35 mg/kg.

### 3.9.3 Spatial Analysis

Spatial analyses were performed for analytes in OU 3 sediments by evaluating patterns of concentrations at discreet sample points in each IHSS. Analytes showing a distinct spatial orientation rather than being randomly distributed may be designated as potential sources or

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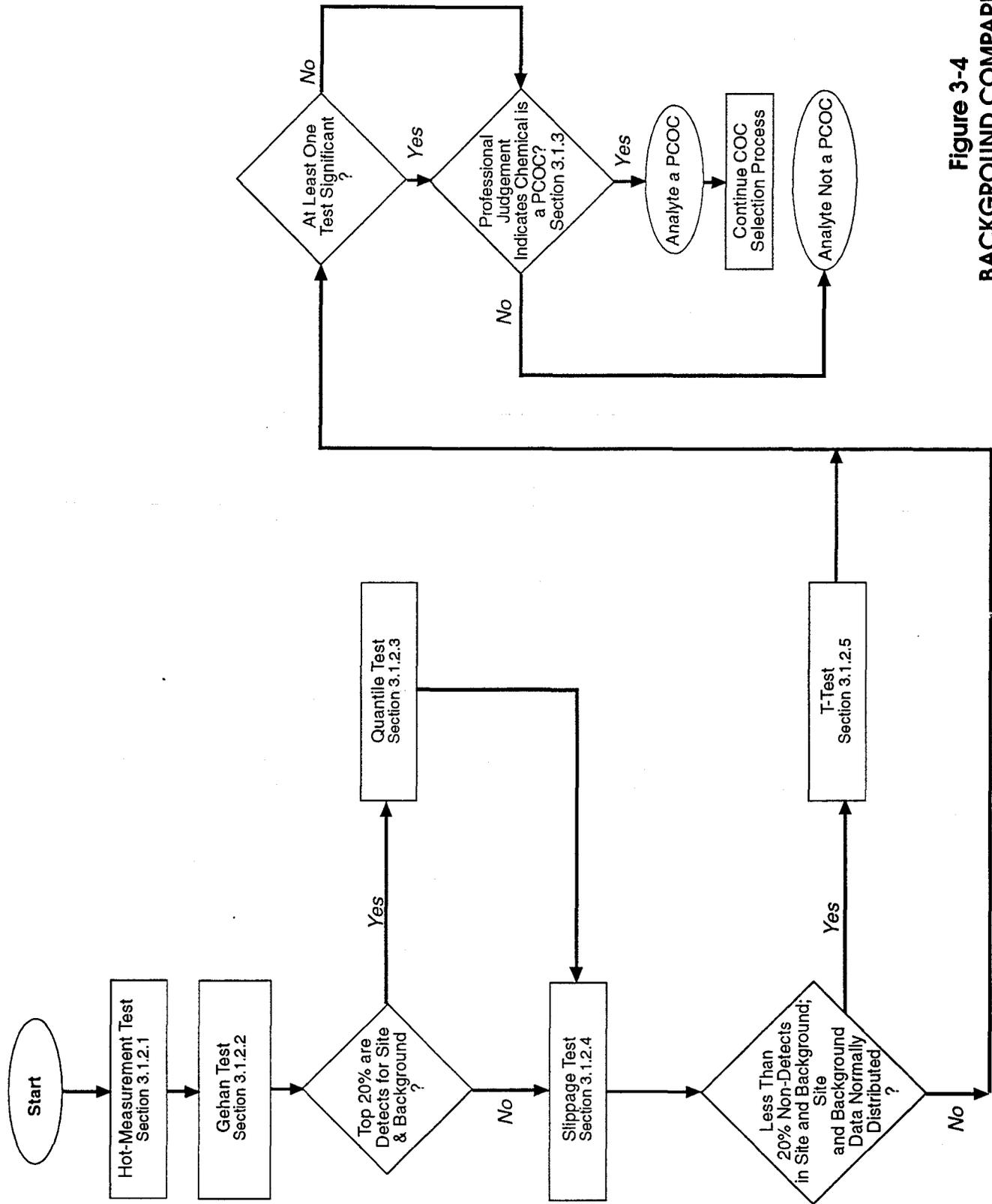
potential hot spots. The physical processes (e.g., sedimentation near the inflow of a stream into a lake) affecting concentration distribution and the contribution of various water sources to OU 3 reservoirs are also assessed.

Arsenic concentrations were plotted at every sediment sample location in each IHSS on a map generated by GIS (see Figures F-1, F-2, and F-3 in Appendix F of this TM). The maps show that the arsenic concentrations tend to be higher in the samples collected in the middle of the reservoir than along the exposed shoreline and stream sediment samples. However, along the shoreline, in the streams, and in the middle areas of the reservoirs the arsenic levels are apparently randomly distributed. There is no discernible pattern of arsenic concentration in sediments, thus suggesting a natural, randomly distributed population. The distribution of data points is further evaluated in Subsection 3.8.4.

Natural limnological phenomena explain the slightly elevated concentrations in the center of the reservoirs. The finer particles of sediment tend to have the highest concentrations of organic matter and thus higher arsenic concentrations (Davis and Kent, 1990). The metals in OU 3 tend to exhibit this natural concentration distribution. The shoreline sediments are exposed most of the year and the finer-grained particles are preferentially removed by wind and water erosion. These finer-sediment particles in the water column also tend to deposit in the center of the lake where flow velocities can no longer support particle suspension.

#### 3.9.4 Probability Plot Analysis

A software package, PROBLOT, was used to assess populations within the OU 3 data sets (see Appendix G). PROBLOT is conventionally used in the minerals exploration industry to guide investigators seeking anomalous mineral deposits (i.e., significantly above background) for extraction (Sinclair, 1986; Sinclair, 1976; Stanley, 1987). In this study, concentration data (detects only) for those chemicals with sufficient data (15 samples above detection limits for a given analyte and IHSS) were lognormally transformed and plotted on a cumulative frequency graph. Based on the cumulative frequency distribution, the number of populations for a given data set were identified. If one population was identified, it was inferred to represent a



**Figure 3-4**  
**BACKGROUND COMPARISON**  
**METHODOLOGY**  
**(SURFACE SOIL DATA ONLY)**

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### **3.1.2.1 Hot-Measurement Test**

The purpose of the Hot-Measurement test is to compare each OU 3 measurement with a "hot-measurement" value to determine whether there are any OU 3 measurements greater than the hot-measurement value. If one or more OU 3 measurements exceeds the hot-measurement value, then the analyte is considered to be a PCOC, pending further investigation. All analytes are carried through the remaining four statistical tests, as appropriate.

For OU 3, the hot-measurement value is an upper tolerance limit (UTL) calculated from the background data. The UTL is an important tool for identifying locations of suspected elevated concentrations on a site (Gilbert, 1993; EPA, 1989b).

A tolerance limit is calculated from the appropriate background data for each analyte. The UTL establishes a concentration (or activity) range that contains a specified proportion (percent) of the population with a specified confidence (probability). The UTL calculated for OU 3 is the value for which there is a 99 percent probability that 99 percent of the population will be below this value. If at least one individual OU 3 value exceeds its respective background UTL, then the hot-measurement test result is significant.

Different methods are used to calculate tolerance limits, depending on whether the data are normally or lognormally distributed. A Shapiro-Wilk distribution test is performed on the background data set to test for normality and lognormality of the data (results of the test are presented in Appendix B).

### **3.1.2.2 Gehan Test**

The Gehan test is a generalization of the Wilcoxon Rank Sum (WRS) test. The hypothesis tested is whether the medians of the two data sets are statistically significantly different from each other with 95 percent confidence. It is used in place of the WRS test where the background and/or site data sets contain multiple detection limits. It is applied without replacing nondetects. The ranking procedure used in the Gehan test gives lower ranks to

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background population based on the comparison to background and benchmark data and the physicochemical processes occurring in the reservoirs. If two populations existed, it is possible that the higher population is the result of contamination. With two populations having low concentrations and concentrations that do not vary significantly between each other, however, the two populations may be explained by natural physical processes and not necessarily contamination (see Appendix G for examples).

According to the geochemical analysis using PROBLOT, only one population is seen for arsenic in each of the three reservoirs. Figure 3-8 shows an example of PROBLOT output for arsenic in Great Western Reservoir (IHSS 200). Because of low concentrations (comparable to benchmark data) and the lack of separate populations, arsenic in OU 3 samples is identified as falling within the background population. Although Standley Lake (IHSS 201) has a maximum that is almost twice that of Great Western Reservoir (IHSS 200) and Mower Reservoir (IHSS 202), the means are essentially equal and fall within benchmark data. Since Mower Reservoir receives 100 percent of its water input from the Rocky Flats Plant drainage area, and Great Western Reservoir and Standley Lake receive 65 percent to more than 90 percent, respectively, of water input from Clear Creek (ASI, 1990) one might expect significantly higher concentrations in Mower Reservoir if RFETS-related contamination were present. However, the arsenic concentrations in Mower Reservoir sediment are not significantly greater than Great Western Reservoir or Standley Lake; this suggests that arsenic originates from background sources and was deposited in the IHSS reservoirs by natural processes.

### 3.9.5 Conclusions from the Weight-of-Evidence Evaluation

Based on the full weight of the evidence presented in this section, the similarity of the OU 3 mean concentrations to background and benchmark, the probability plot analysis, and the lack of discernible spatial trends, arsenic has been eliminated as a COC in surface sediment for the three IHSSs.

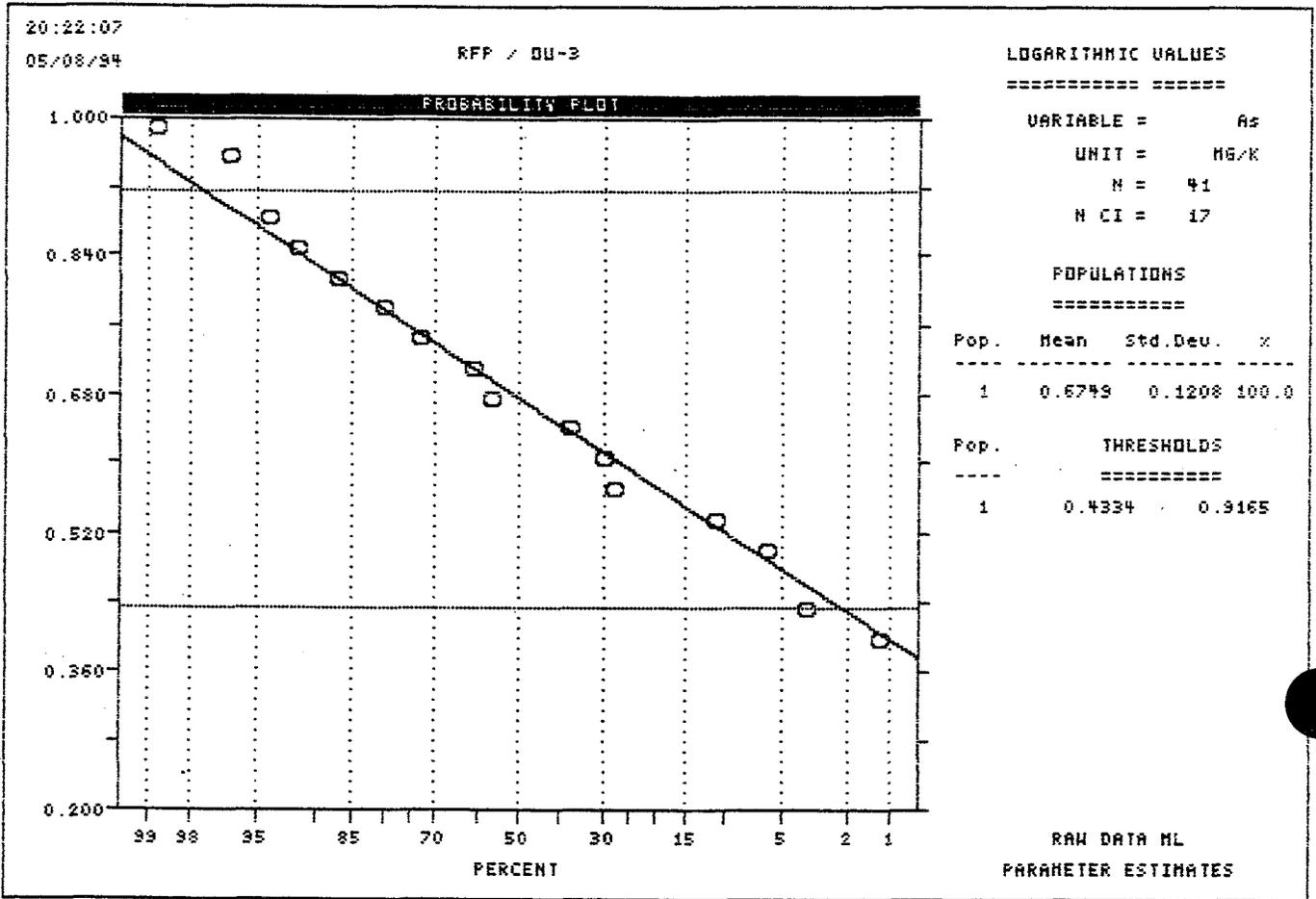


Figure 3-8  
EXAMPLE PROBPLOT - ARSENIC IN  
IHSS 200 SEDIMENTS

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### 3.10 PHASE 1 HISTORICAL PUBLIC EXPOSURES STUDIES ON ROCKY FLATS MATERIALS OF CONCERN

In addition to the weight-of-evidence evaluation, a comparison was made to the Phase 1 Health Studies Materials of Concern to confirm the identification of a chemical as a COC (CDPHE, 1991a; CDPHE, 1991b; CDPHE, 1992).

The Phase 1 Health Studies Materials of Concern evaluation is part of the Rocky Flats Toxicologic Review and Dose Reconstruction Project. This project is part of the 1989 Agreement in Principle that was signed by Governor Romer and former Secretary Watkins that "included DOE funding for increased environmental surveillance and oversight, remediation, emergency preparedness measures, accelerated cleanup in areas of imminent threat, and health studies" (CDPHE, 1994). The project was conducted by ChemRisk under contract to the Colorado Department of Public Health and Environment and consists of the following eight tasks:

1. Identify chemicals used
2. Select materials of concern
3. Reconstruct history of operations
4. Identify release points
5. Estimate releases
6. Select and model exposure pathways
7. Characterize land uses and demographics
8. Perform dose assessment

The Phase 1 Health Studies on Rocky Flats (Task 1), published in 1991 by the Colorado Department of Public Health and the Environment, identified over 8,000 chemicals used in the past at the Rocky Flats site (CDPHE, 1991a). The list was reduced to those chemicals that were most likely to have posed an offsite human health hazard under routine historical plant operations (CDPHE, 1991b). The reduced list (Table 3-2) was prepared using an approach that reviewed a substantial amount of data and subsequently used the weight-of-evidence provided

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by these data to evaluate if the chemical was a material of concern. The list contains 7 solvents, 10 metals (including 10 isotopes of radionuclides), and 8 chemicals classified as others.

Tasks 3 and 4 of the Phase 1 Health Studies on Rocky Flats (CDPHE, 1992) reduced the list even further by recreating the history of operations at the facility and characterizing emission points for releases to the environment. The chemicals in Table 3-3 are the list of materials from Tasks 3 and 4 "for which investigations have conclusively demonstrated that the material has been used at Rocky Flats in significant quantity, and in forms and process that are associated with a reasonable potential for offsite release" (CDPHE, 1992). This list includes six solvents, five metals (including four isotopes of radionuclides), and one chemical classified as others (tritium).

After the weight-of-evidence evaluations were completed, the expanded, conservative list of materials of concern summarized in Table 3-2 is used to confirm the identification of a chemical as a COC.

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TABLE 3-2  
MATERIALS OF CONCERN SELECTED IN TASK 2  
OF THE RFETS HEALTH STUDIES

Solvents	Metals	Others
Benzene	$^{241}\text{Am}$	Benzidine
Carbon tetrachloride	Beryllium	1,3-Butadiene
Chloroform	Cadmium	Ethylene oxide
Methylene chloride	Chromium	Formaldehyde
Tetrachloroethene	Lead	Hydrazine
1,1,1-Trichloroethane	Mercury	Nitric acid
Trichloroethylene	Nickel	Propylene oxide
	$^{238}\text{Pu}$ , $^{239}\text{Pu}$ , $^{240}\text{Pu}$ , $^{241}\text{Pu}$ , $^{242}\text{Pu}$	Tritium
	$^{232}\text{Th}$	
	$^{233}\text{U}$ , $^{234}\text{U}$ , $^{235}\text{U}$ , $^{238}\text{U}$	

Source: Task 2 Report. Selection of Chemicals and Radionuclides of Concern.  
Repository Document TA-723 (CDPHE, 1991b).

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**TABLE 3-3**  
**MATERIALS OF CONCERN SELECTED IN TASKS 3 AND 4**  
**OF THE RFETS HEALTH STUDIES**

Organic Compounds	Metals and Radionuclides	Others
Carbon Tetrachloride	$^{241}\text{Am}$	Tritium
Chloroform	Beryllium	
Methylene Chloride	$^{239/240}\text{Pu}$	
Tetrachloroethene	$^{234/235}\text{U}$ , $^{238}\text{U}$	
1,1,1-Trichloroethane		
Trichloroethylene		

Sources: Reconstruction of Historical Rocky Flats Operations and Identification of Release Points. Project Tasks 3 and 4. Final Report, August 1992 (CDPHE, 1992).

Project Task 5 Report: Estimating Historical Emission from Rocky Flats, 1952-1989, March 1994 (CDPHE, 1994).

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## 4.0 CHEMICALS OF CONCERN IN SURFACE SOILS

### 4.1 INTRODUCTION

Surface soil COCs were identified using the data for OU 3 surface soils, including RFI/RI and Jefferson County Remedy Acres data, and background data for surface soils in the Rock Creek area (DOE, 1993e). Sixty-one samples were collected from RFI/RI surface-soil plots and 47 samples were collected from the Jefferson County Remedy Acres in order to identify COCs in OU 3 surface soils. The purpose of the sampling was to evaluate the presence, activities, and distribution of radionuclides in surface soil. OU 3 surface-soil and background surface-soil sampling locations are shown in Figures 2-1 and 3-3, respectively.

The steps that were followed for the surface-soil COC selection were statistical comparisons of OU 3 and background data (Gilbert's methodology), detection frequency, concentration-toxicity screen, and comparison to PRGs. The radionuclides eliminated during each step in the process are summarized in Table 4-1. The results of each of the steps are described in the following subsections.

### 4.2 DATA EVALUATION

OU 3 surface-soil samples, including RFI/RI and Jefferson County Sampling Area samples, were analyzed for radionuclides (i.e.,  $^{241}\text{Am}$ ,  $^{239/240}\text{Pu}$ ,  $^{233/234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ ). Additionally,  $^{238}\text{Pu}$  was occasionally analyzed for in the OU 3 and Jefferson County Remedy acres data. Plutonium<sup>238</sup> was not analyzed in the background data set, so it did not go through the Gilbert statistics. It was evaluated in the concentration-toxicity screen. Measured activities for radionuclides ranged as follows:

- 0.00 to 0.52 pCi/g for  $^{241}\text{Am}$
- 0.01 to 6.47 pCi/g for  $^{239/240}\text{Pu}$
- 0.53 to 2.14 pCi/g for  $^{233/234}\text{U}$
- 0.01 to 0.12 pCi/g for  $^{235}\text{U}$
- 0.67 to 2.13 pCi/g for  $^{238}\text{U}$

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**TABLE 4-1**  
**COC SELECTION PROCESS<sup>a</sup> RESULTS FOR SURFACE SOILS**  
 (Chemicals are shown below the step by which they were eliminated as a COC)

Zero Detections	Statistical Comparison Tests	Essential Nutrients Screen	Detection Frequency Screen	Concentration-Toxicity Screen	PRG Screen	Weight-of-Evidence Evaluation	COCs
None eliminated	<sup>233/234</sup> U	None eliminated	NA <sup>b</sup>	<sup>238</sup> Pu	NA <sup>c</sup>	NA <sup>c</sup>	<sup>239/240</sup> Pu <sup>241</sup> Am
	<sup>235</sup> U						
	<sup>238</sup> U						

<sup>a</sup>The COC selection process is discussed in Section 3.0.

<sup>b</sup>NA = Not applicable. No radionuclides eliminated by this step. All radionuclides samples were assumed detections for purpose of data analysis.

<sup>c</sup>NA = Not applicable. PRG screen and weight-of-evidence evaluation were not performed for surface soil.

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- 0.00 to 0.05 pCi/g for  $^{238}\text{Pu}$

In general, the highest activities for radionuclides in OU 3 surface soils were measured in samples taken from the area directly east of RFETS within approximately 2 miles of the RFETS boundary. Summary statistics for surface-soil samples (after application of the data protocols and before the COC selection process is applied) are presented in Appendix C (Tables C-1 and C-2). These tables show the summary statistics for each radionuclide analyzed in IHSS 199, including number of detects, number of samples, detection frequency, minimum nondetect value, maximum nondetect value, minimum detected value, maximum detected value, arithmetic mean, geometric standard deviation, 95 percent and lognormal 95 percent UCL. These summary statistics are included in the TM to allow the reader to view the surface-soil data before any data-reduction methods are applied.

#### 4.3 STATISTICAL COMPARISON TO BACKGROUND

As discussed in Subsection 3.1, the data sets for OU 3 and Rock Creek (background) surface soils were considered to be of adequate size for statistical comparisons (i.e., assumptions for the use of activity data were valid), and were collected from areas with generally comparable geologic characteristics. Therefore, the five statistical tests were used to select PCOCs for surface soil (see Subsection 3.1).

Table 4-2 summarizes the results of the statistical comparison tests for each radionuclide. Based on results of the statistical tests,  $^{241}\text{Am}$ ,  $^{239/240}\text{Pu}$ ,  $^{233/234}\text{U}$ , and  $^{238}\text{U}$  are PCOCs. By any of the five comparison tests,  $^{235}\text{U}$  is not a PCOC.

The methodology for selecting PCOCs (Gilbert, 1993) specifies that professional judgement and geochemical analyses be applied after conducting statistical tests, in order to determine if the results of the statistical tests are plausible (Figure 3-2). Americium $^{241}$  and  $^{239/240}\text{Pu}$  were identified as PCOCs by more than one statistical test; based on professional judgement analysis, these radionuclides are considered PCOCs. Historical information from the Final Past Remedy Report OU 3 IHSS 199 (DOE, 1991a) and the pattern of  $^{241}\text{Am}$  and  $^{239/240}\text{Pu}$  activities in surface soils suggest that the reported levels are not attributable to background. However,

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TABLE 4-2  
 COMPARISON OF OU 3 TO BACKGROUND SURFACE SOIL DATA

Analyte	Results of Statistical Test <sup>a</sup>					T-Test
	Hot Measurement	Slippage	Quantile	Gehan		
<sup>241</sup> Am	Yes	Yes	Yes	Yes	Yes	-- <sup>b</sup>
<sup>239/240</sup> Pu	Yes	Yes	Yes	Yes	Yes	Yes
<sup>233/234</sup> U	Yes	No	No	No	No	--
<sup>235</sup> U	No	No	No	No	No	--
<sup>238</sup> U	Yes	No	No	No	No	--

<sup>a</sup>Yes = OU 3 data significantly different from background data.

No = OU 3 data not significantly different from background data.

<sup>b</sup>-- = Test not performed because <sup>241</sup>Am activities from the OU 3 data set did not follow a normal distribution.

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$^{233/234}\text{U}$  and  $^{238}\text{U}$  were statistical PCOCs based on the results of only one statistical test (i.e., Hot-Measurement test). Further professional judgement analysis of the OU 3 data for these radionuclides is described below.

In the Hot-Measurement test,  $^{233/234}\text{U}$  and  $^{238}\text{U}$  each had one exceedance of the corresponding UTL; both exceedances were for sample location PT17992 (see Figure 2-1). Sample location PT17992 is located southeast of Standley Lake and approximately 6 miles from the center of the RFETS facility and approximately 4 miles from the eastern boundary of the RFETS. The UTL for  $^{233/234}\text{U}$  is 1.86 picocuries per gram (pCi/g) and the average activity for  $^{233/234}\text{U}$  measured at PT17992 was 2.14 pCi/g (i.e., average of the activities measured by the CDPHE method,  $1.89 \pm 0.41$  pCi/g, and by the RFETS method,  $2.39 \pm 0.48$  pCi/g). The UTL for  $^{238}\text{U}$  is 2.01 pCi/g and the average activity for  $^{238}\text{U}$  measured at PT17992 was 2.13 pCi/g (i.e., average of the CDPHE method,  $2.08 \pm 0.43$ , and by the RFETS method,  $2.18 \pm 0.45$ ). The magnitude of the exceedances is minimal for both  $^{233/234}\text{U}$  and  $^{238}\text{U}$  (Table 4-3).

Because only one sample location had activities of uranium exceeding the UTLs and the magnitudes of the exceedances were small, the spatial pattern of uranium activity in the vicinity of PT17992 was examined to determine if it was consistent with contamination or natural variation. The activity of uranium and plutonium isotopes measured in soil samples in the vicinity of PT17992 and the approximate distance from the center of RFETS for those samples are summarized in Table 4-4 and Figure 4-1. It is important to note that only PT17992 has  $^{233/234}\text{U}$  and  $^{238}\text{U}$  activities exceeding the UTL – all other surface soil plots do not exceed the UTL. The patterns of  $^{233/234}\text{U}$  activity and  $^{238}\text{U}$  activity do not identify a contaminant plume from the RFETS because, in general, the activities do not decrease with distance from the plant. The activities of  $^{233/234}\text{U}$  in this area vary between 0.83 and 2.14 pCi/g, with the next highest activities compared to PT17992 measured at distances greater than 3.5 miles from the center of the RFETS. The same pattern was observed for  $^{238}\text{U}$  with activities ranging from 0.81 to 2.13 pCi/g. Plutonium  $^{239/240}$  shows the highest activities closer to the RFETS and lower activities farther from the RFETS. The  $^{239/240}\text{Pu}$  trend is more likely related to the windblown contamination from the RFETS.

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TABLE 4-3  
COMPARISON OF URANIUM ACTIVITIES TO THE UTL

	Measured	UTL	Difference	% Difference
<sup>233/234</sup> U	2.14 pCi/g	1.86 pCi/g	0.28 pCi/g	15
<sup>238</sup> U	2.13 pCi/g	2.01 pCi/g	0.12 pCi/g	6

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TABLE 4-4  
 RADIONUCLIDE ACTIVITY WITH DISTANCE FROM RFETS

Sample Location	Approximate Distance from RFP (miles)	Activity* (pCi/g)		
		<sup>233/234</sup> U	<sup>235</sup> U	<sup>239/240</sup> Pu
PT13192	1.75	0.84	0.022	0.87
PT13592	1.75	0.98	0.029	1.15
PT14492	3.00	0.83	0.056	0.81
PT19492	3.00	1.13	0.051	1.09
PT19592	3.50	1.20	0.055	1.08
PT196P2	3.50	1.30	0.054	1.35
PT14592	3.50	1.60	0.115	1.50
PT15592	4.50	1.62	0.023	1.67
PT15692	5.00	0.95	0.062	1.00
PT16492	6.25	0.95	0.027	1.07
PT17992	6.25	2.14	0.049	2.13

\* Average of CDH and RFP sampling methods.

CDH = Colorado Department of Health soil sampling method, see OU 3 Workplan (DOE, 1992) for a description of this method.  
 RFP = Rocky Flats Plant soil sampling method, see OU 3 Workplan (DOE, 1992) for description of this method.

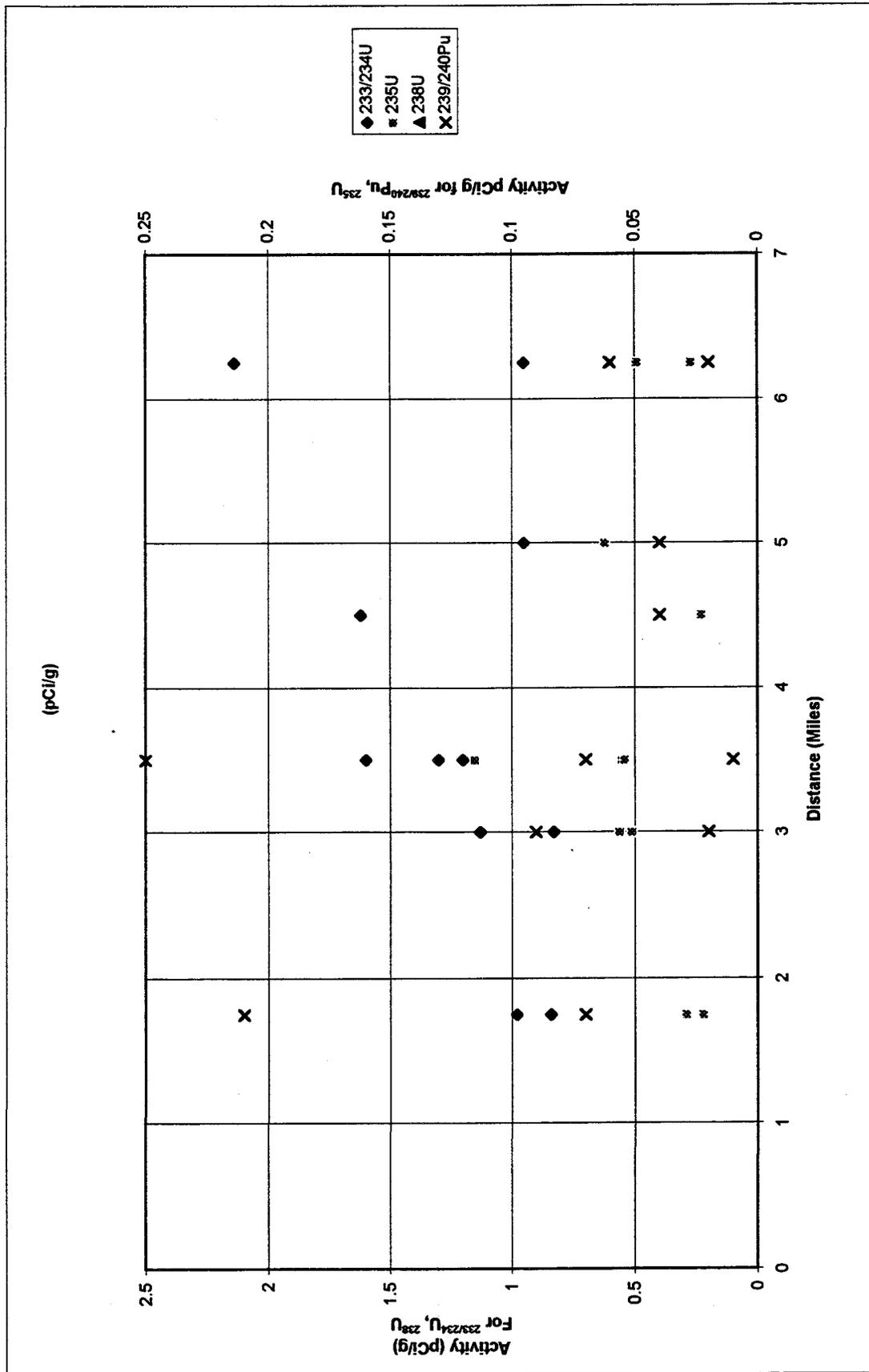


Figure 4-1  
URANIUM ACTIVITY VERSUS DISTANCE FROM RFETS

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The range of activities and the spatial variation for  $^{233/234}\text{U}$  and  $^{238}\text{U}$  measured in surface soil samples in the vicinity of PT17992 suggest that the variability represents sampling/matrix/analytical and natural variability rather than contamination. Therefore,  $^{233/234}\text{U}$  and  $^{238}\text{U}$  were not retained as PCOCs. Further, both  $^{233/234}\text{U}$  and  $^{238}\text{U}$  are more than 20 times lower than the PRG values (Table 4-5).

After application of the Gilbert methodology and professional judgement analysis, the following chemicals are classified as PCOCs for surface soils in OU 3:

- $^{241}\text{Am}$
- $^{239/240}\text{Pu}$

#### 4.4 DETECTION FREQUENCY

Data-evaluation protocols for RFETS state that all radionuclide results are to be treated as detected values in all quantitative data-analysis tasks (Appendix A). Therefore, because surface soil samples were analyzed for radionuclides only, no chemicals were eliminated as COCs based on their frequency of detection; nor were they evaluated further with the PRG screen step of the COC selection process.

#### 4.5 CONCENTRATION-TOXICITY SCREEN

Results of the concentration-toxicity screen for chemicals in surface soils (see Appendix D, Table D-1a) indicate  $^{239/240}\text{Pu}$  and  $^{241}\text{Am}$  are both likely to contribute significantly to the overall risk factor from exposure to surface soil. Plutonium $^{239/240}$  contributes 92 percent of the overall risk factor and  $^{241}\text{Am}$  contributes 8 percent of the overall risk factor. Plutonium $^{238}$  was eliminated because it contributes less than one percent of the overall risk factor (Table 4-1).

#### 4.6 CHEMICALS OF CONCERN

Based on results of the statistical background comparison methodology and concentration-toxicity screen,  $^{239/240}\text{Pu}$  and  $^{241}\text{Am}$  are COCs for surface soil (IHSS 199).

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**TABLE 4-5**  
**COMPARISON OF URANIUM ACTIVITY IN SOIL**  
**SAMPLE PT 17992**  
**PRGs\* (pCi/g)**

	PT17992	PRG
$^{233/234}\text{U}$	2.14	45.3
$^{238}\text{U}$	2.13	46.0

\*Source: DOE, 1994b. PRGs are calculated based on residential exposure scenario.

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## 5.0 CHEMICALS OF CONCERN IN SEDIMENTS

### 5.1 INTRODUCTION

The sediment investigation consisted of the sampling and analysis of sediments from the creeks/drainages (Walnut Creek, Woman Creek, Dry Creek Valley Ditch, Church Ditch, Coal Creek, and Big Dry Creek) and reservoirs (Standley Lake, Great Western Reservoir, and Mower Reservoir) in OU 3. A total of 128 surface-sediment samples (excluding quality-control samples) were collected during the 1983/84 and RFI/RI investigations from 104 sample locations (see Subsection 2.2.2). A total of 155 subsurface-sediment samples (excluding quality-control samples) were collected from 20 sample locations. The purpose of the sediment sampling and subsequent chemical analysis was to characterize radionuclides and metals contained within the creeks/drainages and reservoirs in OU 3.

COCs in sediments were identified using the OU 3 sediment data, background sediment data from the Background Geochemical Characterization Report (BGCR) (DOE, 1993c), background sediment data from the Lowry Landfill Baseline Risk Assessment (EPA, 1992), and other benchmark data.

The results of the COC selection process are shown in Table 5-1. The COC selection procedure is described in detail in Subsection 3.2. The steps in this selection process for sediments were: elimination of essential nutrients, elimination of chemicals detected infrequently, concentration-toxicity screen, comparison to PRGs, and weight-of-evidence evaluations. As previously discussed in Subsection 3.1, statistical comparison tests using the guidance developed by Gilbert (EG&G, 1994a) were not performed for sediment because of incomparability of background and OU data. Based on the COC selection process,  $^{239/240}\text{Pu}$  in IHSS 200 surface sediment is the only chemical identified as a COC. The elimination of water-quality parameters and essential nutrients were discussed in Subsections 2.5 and 3.2, respectively. The remainder of the COC selection steps are described in the following subsections.

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**TABLE 5-1**  
**COC SELECTION PROCESS<sup>a</sup> RESULTS FOR SEDIMENTS**  
 (Chemicals are shown below the test step by which they were eliminated as a COC)

Zero Detections	Statistical Comparison Tests	Essential Nutrients Screen	Detection Frequency Screen	Concentration-Toxicity Screen	PRG Screen	Weight-of-Evidence Evaluation	Chemicals Without a Toxicity Factor <sup>b</sup>	COCs
<b>IHSS 200 - Great Western Reservoir - Surface Sediments (Grab Samples)</b>								
Cyanide	NA <sup>c</sup>	Calcium Magnesium Iron Sodium Potassium	Thallium <sup>d</sup>	Antimony Copper Mercury Molybdenum Nickel Selenium Silver Strontium Tin Vanadium Zinc <sup>226</sup> Ra Tritium <sup>89/90</sup> Sr <sup>137</sup> Cs	Barium Chromium Cadmium <sup>233/234</sup> U <sup>238</sup> U <sup>226</sup> Ra <sup>241</sup> Am	Arsenic Beryllium Manganese <sup>235</sup> U	Aluminum Cesium Cobalt Lead Lithium Silicon	<sup>238/240</sup> Pu
<b>IHSS 200 - Great Western Reservoir - Subsurface Sediments (Core Samples)</b>								
Thallium	NA	Calcium Iron Magnesium Sodium Potassium	None	Copper Mercury Molybdenum Nickel Selenium Silver Strontium Tin Vanadium Zinc	<sup>241</sup> Am <sup>238/240</sup> Pu <sup>210</sup> Po <sup>233/234</sup> U <sup>238</sup> U <sup>235</sup> U Arsenic Barium Beryllium Cadmium Chromium Manganese	None	Aluminum Cesium Cobalt Lead Lithium	None

<sup>a</sup>The COC selection process is discussed in Section 3.0.

<sup>b</sup>Chemicals without toxicity factors are evaluated using the weight-of-evidence evaluation.

<sup>c</sup>NA = Not applicable; statistical tests were not performed because of lack of appropriate background data set.

<sup>d</sup>Thallium will be discussed in the weight-of-evidence section. PRGs were unavailable for comparison.

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**TABLE 5-1**  
**COC SELECTION PROCESS<sup>a</sup> RESULTS FOR SEDIMENTS**  
 (Chemicals are shown below the test step by which they were eliminated as a COC)

Zero Detections	Statistical Comparison Tests	Essential Nutrients Screen	Detection Frequency Screen	Concentration- Toxicity Screen	PRG Screen	Weight-of- Evidence Evaluation	Chemicals Without a Toxicity Factor <sup>b</sup>	COCs
<b>IHSS 201 - Standley Lake - Surface Sediments (Grab Samples)</b>								
Cesium Thallium	NA <sup>c</sup>	Calcium Magnesium Iron Sodium Potassium		Antimony Barium Beryllium Copper Mercury Molybdenum Nickel Selenium Silver Strontium Tin Vanadium Zinc <sup>226</sup> Ra <sup>89/90</sup> Sr Tritium <sup>137</sup> Cs	Chromium Cadmium <sup>233/234</sup> U <sup>238</sup> U <sup>239/240</sup> Pu <sup>226</sup> Ra <sup>241</sup> Am	Arsenic Manganese <sup>235</sup> U	Aluminum Cobalt Lead Lithium Silicon	None
<b>IHSS 202 - Mower Reservoir - Surface Sediments (Grab Samples)</b>								
Cadmium Cyanide Molybdenum 1,1,1-Trichloroethane 1,1,2,2,-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethane 1,1-Dichloroethene 1,2-Dichloroethane 1,2-Dichloroethene 1,2-Dichloropropane 2-Hexanone 4-Methyl-2-pentanone Benzene Bromodichloromethane Bromoform Bromomethane Carbon Disulfide Carbon Tetrachloride Chlorobenzene Chloroethane Chloroform Chloromethane Cis-1,3-Dichloropropene Dibromochloromethane Ethylbenzene Styrene Tetrachloroethene Thallium Trans-1,3-Dichloropropene Trichloroethene Total Xylenes Vinyl Acetate Vinyl Chloride	NA	Calcium Magnesium Iron Sodium Potassium	None	Antimony Copper Mercury Nickel Selenium Silver Strontium Tin Vanadium Zinc Acetone 2-Butanone Methylene chloride Toluene Total xylenes Trichlorotrifluoroethane	Barium Chromium Manganese <sup>233/234</sup> U <sup>235</sup> U <sup>238</sup> U <sup>239/240</sup> Pu <sup>241</sup> Am	Arsenic Beryllium	Aluminum Cesium Cobalt Lead Lithium Silicon Thallium	None

<sup>a</sup>The COC selection process is discussed in Section 3.0.

<sup>b</sup>Chemicals without toxicity factors are evaluated using the weight-of-evidence evaluation.

<sup>c</sup>NA = Not applicable; statistical tests were not performed because of lack of appropriate background data set.

<sup>d</sup>Thallium will be discussed in the weight-of-evidence section. PRGs were unavailable for comparison.

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## 5.2 DATA EVALUATION

The sediment investigation consisted of sampling creeks/drainages and reservoirs in OU 3. The purpose of the sampling was to evaluate the presence, concentrations, and distribution of potential contaminants. Sediment grab samples were collected to characterize the potential lateral extent of contamination in surficial sediments; sediment core samples were collected to characterize the potential vertical extent of contamination in reservoir bottom sediments.

Data for sediment grab samples collected from OU 3 were analyzed for TAL metals and radionuclides (gross alpha/beta,  $^{239/240}\text{Pu}$ ,  $^{241}\text{Am}$ ,  $^{233/234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ ). VOAs were only analyzed for in Mower Reservoir (IHSS 202), and tritium was only analyzed for in Great Western Reservoir (IHSS 200). In addition, a portion of the sediment grab samples were analyzed for  $^{137}\text{Cs}$  (cesium) and  $^{89/90}\text{Sr}$  (strontium). Data for sediment core samples were only evaluated in IHSS 200 (see Subsection 2.8).

A summary of data for the OU 3 surface-sediment samples within each IHSS and for each sediment type (creek/reservoir) is presented in Appendix C (Tables C-4, C-6, C-8, C-10, C-12, and C-13). Summary statistics for subsurface-sediment (core) samples are presented in Table C-5. These summary statistics include the number of detects, number of samples, frequency of detection, minimum nondetected value, maximum nondetected value, minimum detected value, maximum detected value, arithmetic mean, standard deviation, normal 95 percent UCL, and lognormal 95 percent UCL.

## 5.3 DETECTION FREQUENCY

The evaluation of detection frequency serves to identify and eliminate those chemicals that are not detected or are detected only infrequently within a given medium. Chemicals that were not detected (zero percent detection frequency) and chemicals with a low detection frequency (< 5 percent) in sediment samples are summarized in Table 5-1.

In sediment grab samples in IHSS 200, two chemicals (cyanide and thallium) were eliminated. One chemical (thallium) was eliminated based on detection frequency in IHSS 201. In

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IHSS 202, 3 metals and 28 volatile organic compounds (VOCs) were eliminated (VOAs were only analyzed in IHSS 202).

In sediment core samples in IHSS 200, one chemical (thallium) was eliminated based on a zero percent detection frequency. No other analytes were detected below 5 percent in subsurface sediment samples.

As described in Subsection 3.4, chemicals with a detection frequency between zero and 5 percent were compared to 1,000 times the PRG. In surface-sediment samples, thallium was the only chemical that was detected in zero to 5 percent of the samples collected. Because thallium does not have a toxicity factor, it cannot be compared to 1,000 times the PRG. Thus, weight-of-evidence evaluations will be applied to thallium as a special case.

#### 5.4 CONCENTRATION-TOXICITY SCREEN

Chemicals contributing to 99 percent of the risk in the concentration-toxicity screen, as described in Subsection 3.5, are summarized by IHSS in Appendix D. Those chemicals that contribute less than 1 percent of the risk were eliminated as COCs.

As shown in Table 5-1 for surface sediment samples, 15 chemicals were eliminated in IHSS 200, 17 chemicals were eliminated in IHSS 201, and 16 chemicals were eliminated in IHSS 202 based on this criterion.

In subsurface sediment samples, 10 chemicals were eliminated in IHSS 200 based on the concentration-toxicity screen (see Table 5-1).

#### 5.5 PRG SCREEN

Based on the PRG screen presented in Programmatic Preliminary Remediation Goals (DOE, 1994b), seven chemicals were eliminated in IHSS 200, seven chemicals were eliminated in IHSS 201, and eight chemicals were eliminated in IHSS 202 surface sediments. Twelve chemicals were eliminated in IHSS 200 subsurface sediments (see Table 5-1). These

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preliminary remediation goals (PRGs) were based on the residential exposure scenario for the ingestion of sediments. The PRG calculations and results are presented in Appendix E.

## 5.6 WEIGHT-OF-EVIDENCE EVALUATION

The following chemicals in surface sediments remain for discussion in the weight-of-evidence section after passing through each screen in the COC selection process:

### IHSS 200

- Arsenic (Maximum – 9.4 mg/kg, PRG = 0.3659 mg/kg)
- Beryllium (Maximum – 1.6 mg/kg, PRG = 0.1489 mg/kg)
- Manganese (Maximum – 1,550 mg/kg, PRG = 1,364 mg/kg)
- <sup>235</sup>U (Maximum – 0.56 pCi/g, PRG = 0.173 pCi/g)

### IHSS 201

- Arsenic (Maximum – 17.7 mg/kg, PRG = 0.3659 mg/kg)
- Manganese (Maximum – 4,450 mg/kg, PRG = 1,364 mg/kg)
- <sup>235</sup>U (Maximum – 0.2 pCi/g, PRG = 0.173 pCi/g)

### IHSS 202

- Arsenic (Maximum – 10.4 mg/kg, PRG = 0.3569 mg/kg)
- Beryllium (Maximum – 1.5 mg/kg, PRG = 0.1489 mg/kg)

No chemicals in subsurface sediments with available toxicity factors remain for weight-of-evidence evaluations.

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At this point, several other chemicals have not been eliminated from the COC list because of a lack of available toxicity factors. These chemicals include the following and are applicable to all IHSSs:

- Aluminum
- Cesium
- Cobalt
- Lead
- Lithium
- Silicon
- Thallium

These chemicals are discussed in Subsection 5.6.2; thallium was eliminated as a COC in subsurface sediments based on detection frequency and will not be discussed in the weight-of-evidence evaluations for subsurface sediments.

The analytes remaining after the PRG screen (Table 5-1) were evaluated using the weight-of-evidence evaluation described in Subsection 3.7 to determine if the analyte was consistently detected above benchmark levels and therefore a COC. Comparisons were made on an IHSS-specific basis in creek and reservoir sediments. The following criteria were used in the weight of evidence evaluations:

- Comparison of means, standard deviations, and ranges of OU 3 sediment data to BGCR (DOE, 1993c) sediment data
- Background sediment data for the Lowry Landfill Superfund site (EPA, 1992) and literature benchmark data
- Probability plot analysis evaluating chemical data populations in OU 3 sediments
- Temporal analyses of sediment cores to identify seasonal variations or sampling anomalies

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- Spatial analyses of sediment grab samples in each IHSS

Metal concentrations in OU 3 creek sediments were compared to the means and maximums in the BGCR (DOE, 1993c) and the background data sets from the Lowry Landfill Superfund site (EPA, 1992). The BGCR (DOE, 1993c) contains background concentrations for a wide variety of chemicals. Sampling areas for this study include creeks and drainages outside of the RFETS boundaries. Data for radionuclides were only available from the BGCR (DOE, 1993c). The background data set from the Lowry Landfill Superfund site (EPA, 1992) consisted of data from creeks approximately 1 mile from the southern half of the landfill. No data for radionuclides were available from the Lowry Landfill Superfund site background data set. Data for OU 3 reservoir sediments were compared to a variety of benchmark literature means only; no ranges were available. Subsection 3.7.1 summarizes the literature sources gathered for benchmark comparison to OU 3 sediments. Appendix G summarizes OU 3, background, and benchmark data for sediments. Where appropriate, a 95 percent estimated upperbound concentration (mean plus two standard deviations) was used in comparing OU 3 data to background concentrations. Tables 5-2 and 5-3 present the summary statistics by IHSS for the chemicals evaluated by the weight-of-evidence evaluation for surface-sediment data and subsurface-sediment data, respectively. A summary of the background and benchmark data is also included in Table 5-2 and Table 5-3.

As with all sampling activities, a certain amount of variability exists. Natural variability is discussed in detail in Appendix G. Sampling variability exists between sample locations at OU 3, because both nearshore and deep sediment grab samples were combined into one data set. Whereas nearshore sediment is usually coarse-grained, deep sediment tends to be finer-grained and rich in organics (Davis and Kent, 1990). Analytical variability was determined based on historical relative percent differences (RPDs). These historical RPDs represent acceptable laboratory precision levels referenced from Data Quality Objectives for Remedial Response Activities OSWER 9355.0-7B (EPA, 1987).

PROBPLOT, an analysis tool, was used for assessing populations within a data set (see Appendix G). In the case of OU 3, analytes were evaluated on an IHSS-by-IHSS basis. Concentrations for those elements with sufficient data were plotted lognormally. If a single

TABLE 6-2  
 SUMMARY STATISTICS FOR SURFACE SEDIMENTS BY IHSS FOR WEIGHT-OF-EVIDENCE EVALUATIONS

Chemical Name METALS (mg/kg)	IHSS or Benchmark	Lake or Creek	Area	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetected Value	Maximum Nondetected Value	Minimum Detected Value	Maximum Detected Value	Mean	Standard Deviation	Coefficient of Variation
ALUMINUM	BGCR	CREEK	B	59	59	1.00			549.00	25200.00	5887.610	4912.73	0.47
ALUMINUM	200	CREEK	S	8	8	1.00			2220.00	13800.00	8233.750	3848.05	0.99
ALUMINUM	201	CREEK	S	14	14	1.00			1900.00	33200.00	8030.714	7958.47	0.24
ALUMINUM	202	CREEK	S	4	4	1.00			9110.00	15200.00	11227.500	2718.15	
ALUMINUM	BM	LAKE	B						96700.00	96700.00			
ALUMINUM	200	LAKE	S	36	36	1.00			4530.00	20800.00	10910.833	4212.31	0.39
ALUMINUM	201	LAKE	S	43	43	1.00			852.00	23500.00	9834.814	6623.01	0.67
ALUMINUM	202	LAKE	S	15	15	1.00			7480.00	18300.00	14370.000	3096.10	0.22
ALUMINUM	LOWRY	CREEK	B							32,100	13,959.33	7080.88	
ARSENIC	BGCR	CREEK	B	53	59	1.00			0.20	17.30	2.410	2.45	
ARSENIC	200	CREEK	S	8	8	1.00			3.70	9.40	5.313	1.85	0.35
ARSENIC	201	CREEK	S	14	14	1.00			2.20	7.80	4.764	1.53	0.32
ARSENIC	202	CREEK	S	4	4	1.00			3.00	6.80	4.875	1.56	0.32
ARSENIC	BM	LAKE	B						0.79	5.57	8.400		
ARSENIC	200	LAKE	S	36	36	1.00			2.60	9.40	4.906	1.46	0.30
ARSENIC	201	LAKE	S	43	43	1.00			1.20	17.70	6.963	4.34	0.62
ARSENIC	202	LAKE	S	15	15	1.00			2.20	10.40	5.147	1.96	0.38
ARSENIC	RMNP-BM (L. Husted)	LAKE	B								2.5	0.2	
ARSENIC	RMNP-BM (L. Louise)	LAKE	B								2.5	0.3	
ARSENIC	RMNP-BM (L. Haiyaha)	LAKE	B								8.4	0.2	
ARSENIC	RMNP-BM (The Loch)	LAKE	B								1.4	0.2	
ARSENIC	LOWRY	CREEK	B							16.50	4.81	3.95	

B = Background.  
 S = Site.

BGCR = Background Geochemical Characterization Report (DOE, 1993b)  
 CC-BM = Cherry Creek Reservoir Surface Sediment (n=1) (CCBA, 1994)  
 RMNP-BM = Rocky Mountain National Park Lakes Surface Sediment Data (Helt, et al., 1984)  
 LOWRY = Lowry Landfill Site Background Data (Stream Sediment) (EPA, 1992)

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TABLE 6-2  
 SUMMARY STATISTICS FOR SURFACE SEDIMENTS BY IHSS FOR WEIGHT-OF-EVIDENCE EVALUATIONS

Chemical Name	IHSS or Benchmark	Lake or Creek	Area	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetected Value	Maximum Nondetected Value	Minimum Detected Value	Maximum Detected Value	Mean	Standard Deviation	Coefficient of Variation
<b>METALS (mg/kg)</b>													
BERYLLIUM	BGCR	CREEK	B	27	57	0.47			1.50	1.30	0.660	1.89	0.45
BERYLLIUM	200	CREEK	S	8	8	1.00			0.24	1.60	0.851	0.38	0.45
BERYLLIUM	201	CREEK	S	14	14	1.00			0.22	1.50	0.577	0.31	0.54
BERYLLIUM	202	CREEK	S	3	3	1.00			0.41	1.40	0.783	0.54	0.69
BERYLLIUM	BM	LAKE	B						3.90	4.03	9.300		
BERYLLIUM	200	LAKE	S	36	36	1.00			0.37	1.40	0.850	0.27	0.31
BERYLLIUM	201	LAKE	S	39	43	0.91	0.06	0.07	0.15	1.60	0.700	0.47	0.67
BERYLLIUM	202	LAKE	S	13	14	0.93	1.00	1.00	0.54	1.50	1.061	0.27	0.25
BERYLLIUM	RMNP-BM (L. Husted)	LAKE	B								3.9	1.0	
BERYLLIUM	RMNP-BM (L. Louise)	LAKE	B								5.0	3.0	
BERYLLIUM	RMNP-BM (L. Haiyaha)	LAKE	B								9.3	1.1	
BERYLLIUM	RMNP-BM (The Loch)	LAKE	B								7.4	1.3	
BERYLLIUM	LOWRY	CREEK	B							2.1	1.0	0.5	
CESIUM	BGCR	CREEK	B	10	56	0.18			0.56	157.00	69.290	63.88	0.15
CESIUM	200	CREEK	S		8		44.95	66.50			53.381	8.03	0.80
CESIUM	201	CREEK	S	3	14	0.21	6.95	104.50	3.10	19.90	40.850	32.84	0.80
CESIUM	202	CREEK	S	3	4	0.75	126.50	126.50	1.80	2.00	33.050	62.30	1.89
CESIUM	200	LAKE	S	9	36	0.25	6.90	78.50	14.10	29.70	36.008	26.06	0.72
CESIUM	201	LAKE	S		37		5.80	71.00			26.968	25.39	0.94
CESIUM	202	LAKE	S	1	9	0.11	1.25	15.75	69.80	69.80	14.744	21.57	1.46

BGCR = Background Geochemical Characterization Report (DOE, 1993b)

CC-BM = Cherry Creek Reservoir Surface Sediment (n=1) (CCBA, 1994)

RMNP-BM = Rocky Mountain National Park Lakes Surface Sediment Data (Heit, et al., 1984)

LOWRY = Lowry Landfill Site Background Data (Stream Sediment) (EPA, 1992)

B = Background.

S = Site.

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TABLE 5-2  
 SUMMARY STATISTICS FOR SURFACE SEDIMENTS BY IHSS FOR WEIGHT-OF-EVIDENCE EVALUATIONS

Chemical Name	IHSS or Benchmark	Lake or Creek	Area	Number of Defects	Number of Samples	Frequency of Detection	Minimum Nondetected Value	Maximum Nondetected Value	Minimum Detected Value	Maximum Detected Value	Mean	Standard Deviation	Coefficient of Variation
COBALT	BGCR	CREEK	B	43	59	0.80			0.30	15.00	5.040	3.29	0.53
COBALT	200	CREEK	S	8	8	1.00			4.50	23.30	11.250	6.00	0.28
COBALT	201	CREEK	S	14	14	1.00			2.90	10.90	7.900	2.20	0.17
COBALT	202	CREEK	S	4	4	1.00			6.30	9.60	7.825	1.36	
COBALT	BM	LAKE	B						21.30	21.30			
COBALT	200	LAKE	S	36	36	1.00			3.50	13.50	8.664	2.03	0.23
COBALT	201	LAKE	S	43	43	1.00			1.30	13.20	7.049	3.53	0.50
COBALT	202	LAKE	S	14	15	0.93	5.85	5.85	4.40	15.30	8.357	2.55	0.31
COBALT	LOWRY	CREEK	B							14.00	9.2	2.86	
LEAD	BGCR	CREEK	B	59	59	1.00			2.10	244.00	22.020	36.79	0.51
LEAD	200	CREEK	S	8	8	1.00			5.30	36.20	18.513	9.36	0.55
LEAD	201	CREEK	S	14	14	1.00			17.20	91.40	38.450	21.06	0.23
LEAD	202	CREEK	S	4	4	1.00			12.30	21.60	16.775	3.81	
LEAD	BM	LAKE	B						10.00	55.00	43.000		
LEAD	200	LAKE	S	36	36	1.00			13.00	88.20	31.372	18.81	0.59
LEAD	201	LAKE	S	43	43	1.00			2.90	317.00	83.747	67.11	1.05
LEAD	202	LAKE	S	15	15	1.00			14.50	40.80	29.987	7.75	0.26
LEAD	RMNP-BM (L. Husted)	LAKE	B							43		0	
LEAD	RMNP-BM (L. Louise)	LAKE	B							26		2	
LEAD	RMNP-BM (L. Haiyaha)	LAKE	B							14		2	
LEAD	RMNP-BM (The Loch)	LAKE	B										
LEAD	LOWRY	CREEK	B							380	28.29	66.69	

B = Background.  
 S = Site.

BGCR = Background Geochemical Characterization Report (DOE, 1993b)  
 CC-BM = Cherry Creek Reservoir Surface Sediment (n=1) (CCBA, 1994)  
 RMNP-BM = Rocky Mountain National Park Lakes Surface Sediment Data (Heit, et al., 1984)  
 LOWRY = Lowry Landfill Site Background Data (Stream Sediment) (EPA, 1992)

TABLE 6-2  
 SUMMARY STATISTICS FOR SURFACE SEDIMENTS BY IHSS FOR WEIGHT-OF-EVIDENCE EVALUATIONS

Chemical Name	IHSS or Benchmark	Lake or Creek	Area	Number of Defects	Number of Samples	Frequency of Detection	Minimum Nondetected Value	Maximum Nondetected Value	Minimum Detected Value	Maximum Detected Value	Mean	Standard Deviation	Coefficient of Variation
<b>METALS (mg/kg)</b>													
LITHIUM	BGCR	CREEK	B	41	57	0.72			1.15	20.20	7.480	5.26	0.48
LITHIUM	200	CREEK	S	8	8	1.00			1.80	11.50	6.650	3.19	1.01
LITHIUM	201	CREEK	S	14	14	1.00			2.10	34.60	8.207	4.49	0.47
LITHIUM	202	CREEK	S	4	4	1.00			3.10	17.60	8.958	3.09	0.34
LITHIUM	200	LAKE	S	36	36	1.00			0.24	17.10	7.529	4.84	0.64
LITHIUM	201	LAKE	S	42	43	0.98	0.24	0.24	7.95	13.90	11.017	2.37	0.22
LITHIUM	202	LAKE	S	14	15	0.93	7.95	7.95					
MANGANESE	BGCR	CREEK	B	58	59	0.98			9.00	1280.00	227.820	215.48	0.77
MANGANESE	200	CREEK	S	8	8	1.00			155.00	1550.00	684.000	526.56	0.85
MANGANESE	201	CREEK	S	14	14	1.00			83.50	4450.00	1706.179	1447.03	0.77
MANGANESE	202	CREEK	S	4	4	1.00			238.00	1170.00	548.000	423.63	0.50
MANGANESE	BM	LAKE	B	36	36	1.00			739.00	739.00	425.914	211.90	0.99
MANGANESE	200	LAKE	S	36	43	1.00			40.50	813.00	595.379	592.16	0.65
MANGANESE	201	LAKE	S	43	43	1.00			89.60	2080.00	297.800	194.93	0.65
MANGANESE	202	LAKE	S	15	15	1.00			148.00	925.00	297.800	281.36	0.80
MANGANESE	LOWRY	CREEK	B	19	19	1.00			1560.00	1560.00	805.10	362.31	0.80
SILICON	BGCR	CREEK	B	19	19	1.00			128.00	1450.00	331.530	365.62	0.80
SILICON	200	CREEK	S	8	8	1.00			281.00	1020.00	459.125	837.25	0.80
SILICON	201	CREEK	S	8	8	1.00			412.00	3290.00	1167.500	837.25	0.53
SILICON	202	CREEK	S	1	1	1.00			115.00	412.00	237.667	125.31	0.40
SILICON	200	LAKE	S	15	15	1.00			82.00	650.00	197.308	79.13	0.40
SILICON	201	LAKE	S	13	13	1.00				396.00	197.308	79.13	0.40

BGCR = Background Geochemical Characterization Report (DOE, 1993b)  
 CC-BM = Cherry Creek Reservoir Surface Sediment (n=1) (CCBA, 1994)  
 RMNP-BM = Rocky Mountain National Park Lakes Surface Sediment Data (Heft, et al., 1984)  
 LOWRY = Lowry Landfill Site Background Data (Stream Sediment) (EPA, 1992)

B = Background.  
 S = Site.

TABLE 6-2

SUMMARY STATISTICS FOR SURFACE SEDIMENTS BY IHSS FOR WEIGHT-OF-EVIDENCE EVALUATIONS

Chemical Name	IHSS or Benchmark	Lake or Creek	Area	Number of Detects	Number of Samples	Frequency of Detection	Minimum Value		Maximum Value		Mean	Standard Deviation	Coefficient of Variation
							Non-detected	Detected	Non-detected	Detected			
<b>METALS (mg/kg)</b>													
THALLIUM	200	CREEK	S		8		0.16	0.23			0.199	0.02	0.12
THALLIUM	201	CREEK	S	2	14	0.14	0.12	0.75	0.28	0.38	0.256	0.16	0.63
THALLIUM	202	CREEK	S	1	4	0.25	0.11	0.43	0.25	0.25	0.223	0.15	0.68
THALLIUM	BGCR	CREEK	B	2	50	0.04				0.40	0.300	0.23	
THALLIUM	200	LAKE	S	1	36	0.03	0.18	1.30	0.95	0.95	0.398	0.26	0.66
THALLIUM	201	LAKE	S		38		0.23	1.95			0.481	0.40	0.83
THALLIUM	202	LAKE	S		8		0.15	1.20			0.856	0.48	0.74
<b>RADIONUCLIDES (pCi/g)</b>													
URANIUM 235	BGCR	CREEK	B	49	49	1.00			0.40	0.19	0.060	0.05	
URANIUM 235	200	CREEK	S	7	7	1.00			0.03	0.20	0.072	0.06	0.86
URANIUM 235	201	CREEK	S	14	14	1.00			0.03	0.20	0.078	0.04	0.58
URANIUM 235	202	CREEK	S	4	4	1.00			0.06	0.14	0.085	0.04	0.44
URANIUM 235	BM	LAKE	B					5.51		11.400			
URANIUM 235	200	LAKE	S	33	35	0.94	0.00	0.02	0.01	0.56	0.071	0.09	1.29
URANIUM 235	201	LAKE	S	33	37	0.89	0.00	0.02	0.00	0.12	0.045	0.03	0.75
URANIUM 235	202	LAKE	S	15	15	1.00			0.01	0.17	0.070	0.04	0.68

B = Background.

S = Site.

BGCR = Background Geochemical Characterization Report (DOE, 1993b)

CC-BM = Cherry Creek Reservoir Surface Sediment (p=1) (CCBA, 1994)

RWMP-BM = Rocky Mountain National Park Lakes Surface Sediment Data (Heit, et al., 1984)

LOWRY = Lowry Landfill Site Background Data (Stream Sediment) (EPA, 1992)

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TABLE 6-3  
 SUMMARY STATISTICS OF GREAT WESTERN RESERVOIR SUBSURFACE SEDIMENTS FOR WEIGHT-OF-EVIDENCE EVALUATIONS

Chemical Name	Units	IHSS	Lake or Creek	Area	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetected Value	Maximum Nondetected Value	Minimum Detected value	Maximum Detected Value	Mean	Standard Deviation	Coefficient of Variation
ALUMINUM	mg/kg	200	LAKE	S	46	46	1.00			6340.00	26100.00	13893.70	5457.02	0.39
ALUMINUM	mg/kg	BGCR	CREEK	B	59	59	1.00			549.00	25200.00	5887.610	4912.73	
ALUMINUM	mg/kg	BM	LAKE	B						96700.00	96700.00			
ALUMINUM	mg/kg	LOWRY	CREEK	B							32100.00	13959.33	7080.88	
CESIUM	mg/kg	200	LAKE	S	26	46	0.57	12.70	27.40	12.70	39.20	16.74	7.64	0.46
COBALT	mg/kg	200	LAKE	S	46	46	1.00			5.90	12.20	9.35	1.38	0.15
COBALT	mg/kg	BGCR	CREEK	B	43	59	0.50			0.30	15.00	5.040	3.29	
COBALT	mg/kg	BM	LAKE	B						21.30	21.30			
COBALT	mg/kg	LOWRY	CREEK	B							14.00	9.2	2.86	
LEAD	mg/kg	200	LAKE	S	46	46	1.00			14.50	128.00	47.21	27.02	0.57
LEAD	mg/kg	BGCR	CREEK	B	59	59	1.00			10.00	244.00	22.020	36.79	
LEAD	mg/kg	BM	LAKE	B							43.000			
LEAD	mg/kg	RMNP-BM (L. Husted)	LAKE	B								43	0	
LEAD	mg/kg	RMNP-BM (L. Louise)	LAKE	B								26	2	
LEAD	mg/kg	RMNP-BM (L. Halvaha)	LAKE	B								14	2	
LEAD	mg/kg	RMNP-BM (The Loch)	LAKE	B								28.29	66.79	
LEAD	mg/kg	LOWRY	CREEK	B							380.00			
LITHIUM	mg/kg	200	LAKE	S	46	46	1.00			5.40	19.60	11.66	3.90	0.33
LITHIUM	mg/kg	BGCR	CREEK	B	41	57	0.72			1.15	20.20	7.460	5.26	

B = Background  
 S = Site

BGCR Creek = Background Geochemical Characterization Report (DOE, 1993c)  
 RMNP-BM = Rocky Mountain National Park Lakes Surface Sediment Data (Hiet, 1984)  
 RMNP-BMS = Rocky Mountain National Park Lakes Subsurface Sediment Data (Hiet, 1984)  
 BM Lake = Benchmark Lake Data, Rocky Mountain National Park Subsurface for Lead only (Hiet et al., 1984) and Cherry Creek Reservoir Surface Sediment (CCBA, 1994)  
 LOWRY = Lowry Landfill Site Background Data (Stream Sediment) (EPA, 1992)

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population was noted (i.e., a straight line), it was presumed that the samples represented background levels. This conclusion assumes that a background population must exist, and if a single population is observed, all samples must be associated with that background population. If two populations are seen, it is conceivable that the population of higher values represents source contamination. If, however, both populations consist of low concentrations, the two populations may be explained by natural physical processes and do not necessarily represent contamination (see Appendix G).

Another weight-of-evidence evaluation included spatial analyses: evaluating patterns of concentrations at discrete sample points in each IHSS. Analytes showing a distinct spatial orientation rather than being randomly distributed may be designated as potential sources or potential hot spots. However, if no identifiable patterns or trends were noted, the distribution of chemical concentrations was attributed to natural processes (Appendix F).

Core profiles were analyzed for some analytes (if sufficient data existed) to evaluate if possible patterns existed throughout the sediment layer. Concentration levels sharply elevated at one point in time may indicate a historical release event contributing to concentrations above background. However, if there are no perceivable trends, this suggests that the analyte is occurring naturally without any source contamination.

The following subsections discuss weight-of-evidence evaluations for chemicals in surface sediments that exceed the PRGs (Subsection 5.6.1), chemicals in surface sediments without toxicity factors (Subsection 5.6.2), and chemicals in subsurface sediments without toxicity factors (Subsection 5.6.3).

#### **5.6.1 Weight-of-Evidence Evaluations for Chemicals Exceeding PRGs**

##### **5.6.1.1 Arsenic**

A more detailed description of the weight-of-evidence evaluation of arsenic is presented in Subsection 3.9. Mean concentrations of arsenic in OU 3 creek sediments (5.3 mg/kg, 4.8 mg/kg, 4.9 mg/kg in IHSSs 200, 201, and 202, respectively) were consistent with the

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Lowry Landfill Superfund site background mean (5 mg/kg) (EPA, 1992), and were less than the mean plus two standard deviations (7.3 mg/kg) as given in the BGCR (DOE, 1993c). The maximum concentration (17 mg/kg) in background creek sediments was greater than the maximum detected concentrations in OU 3 creek sediments (9.4 mg/kg, 7.8 mg/kg, 6.8 mg/kg in IHSSs 200, 201, and 202, respectively). Mean concentrations of arsenic in OU 3 reservoir sediments (4.9 mg/kg, 7.0 mg/kg, 5.2 mg/kg in IHSSs 200, 201, and 202, respectively) were similar or less than reservoir benchmark literature means (range: 1.0 to 8.4 mg/kg) and less than worldwide means (7.2 mg/kg). Maximum concentrations of arsenic in OU 3 reservoir sediments (9.4 mg/kg, 17.7 mg/kg, 10.4 mg/kg in IHSSs 200, 201, and 202, respectively) were within the worldwide benchmark ranges (0.1 to 55 mg/kg).

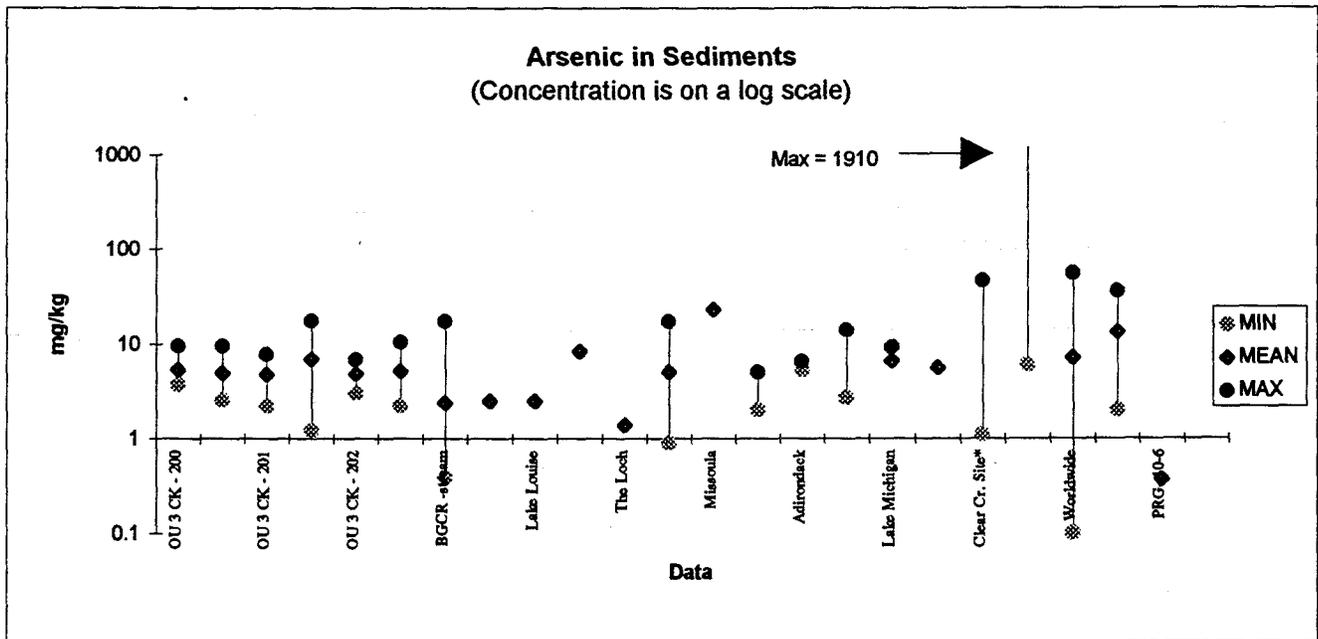
The range of arsenic concentrations for various sources is depicted in Figure 5-1. These sources include Superfund sites, background ranges, benchmark ranges, and the OU 3 data. Concentrations of arsenic in OU 3 sediments are below the mean concentrations in other Superfund sites and are comparable to background and benchmark levels. Additionally, the concentrations of arsenic in OU 3 sediments are consistent; there are no apparent spurious data that would suggest anomalous concentrations. The purpose of using information from contaminated sites in addition to nonimpacted sites is to place OU 3 levels in perspective with other investigated sites.

According to the PROBLOT analysis, only one population of arsenic was identified in each of the three reservoirs (Appendix G). Although the means for each of the IHSSs are similar, IHSS 201 has a maximum that is almost twice that of IHSSs 200 and 202. This higher maximum concentration may be a result of the sediments from Clear Creek, a highly mineralized drainage. Because of low concentrations and the lack of separate populations, concentrations of arsenic in OU 3 samples were identified as being consistent with the background population (see Appendix G).

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of arsenic concentrations, thus indicating a natural population. The maps show that the arsenic concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoirs (Appendix F).

**ARSENIC IN SEDIMENTS**  
(mg/kg)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3 CK - 200	3.7	5.31	9.4	1.85	Great Western Reservoir (Creek) (OU 3 Database)
OU 3 LK - 200	2.6	4.91	9.4	1.46	Great Western Reservoir (Lake) (OU 3 Database)
OU 3 CK - 201	2.2	4.76	7.8	1.53	Standley Lake (Creek) (OU 3 Database)
OU 3 LK - 201	1.2	6.96	17.7	4.34	Standley Lake (Lake) (OU 3 Database)
OU 3 CK - 202	3	4.88	6.8	1.56	Mower Reservoir (Creek) (OU 3 Database)
OU 3 LK - 202	2.2	5.15	10.4	1.96	Mower Reservoir (Lake) (OU 3 Database)
BGCR -stream	0.39	2.4	17.3	2.45	RFP Background Stream Sediments, BGCR (DOE, 1993c)
Lake Husted		2.5		0.2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lake Louise		2.5		0.3	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lake Haiyaha		8.4		0.2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
The Loch		1.4		0.2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lowry	0.9	5	17	4	Lowry Landfill Background Stream Sediment OUs 2-5 Baseline Risk Assessment (EPA, 1992)
Missoula		23			Missoula Lake Beds Surface Sediment (Moore and Ramamoorthy, 1984)
Great Lakes	2		5		Great Lakes Surface Sediment (Fergusson, 1990)
Adirondack	5.3		6.5		Lake Adirondack Surface Sediment (Fergusson, 1990)
Niagara R.	2.7		14		Niagara River Sediment (polluted) (Fergusson, 1990)
Lake Michigan		6.6	9.2		Lake Michigan Surface Sediment (Fergusson, 1990)
Cherry Creek		5.57			Cherry Creek Reservoir Surface Sediment (CCBA, 1994)
Clear Cr. Site*	1.1		46		Clear Creek Superfund Site (CDPHE, 1990)
Warm Springs	6		1910		Warm Springs Pond Superfund Site, Pond Bottom Sediments (EPA, 1988)
Worldwide	0.1	7.2	55	7.2	Worldwide Sediment (Boyle & Jonasson, 1973)
Peaty Soils	2	13.4	36	9.4	Peaty Soils (Boyle & Jonasson, 1973)
PRG-10 <sup>6</sup>		0.37			10 <sup>6</sup> PRG level based on a residential soil scenario (EG&G, 1994a)



Notes: If blank, no data are available.

\*Indicates Superfund site.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 5-1**  
**ARSENIC IN SEDIMENTS**

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Based on the similarity of the data sets, the PROBLOT analysis, and the lack of discernible spatial trends, it has been determined that arsenic concentrations in OU 3 sediments are within background ranges; therefore, arsenic has been eliminated as a COC for all three IHSSs. This conclusion is supported by the Phase 1 Health Studies, which did not identify arsenic as a material of concern (CDPHE, 1991b).

#### 5.6.1.2 Beryllium

Beryllium was screened out as a COC in IHSS 201 by the concentration-toxicity screen. Mean concentrations of beryllium in OU 3 creek sediments (0.9 mg/kg and 0.8 mg/kg in IHSSs 200 and 202, respectively) were consistent with the Lowry Landfill Superfund site background mean (1.0 mg/kg) (EPA, 1992) and less than the mean plus two standard deviations (4.0 mg/kg) given in the BGCR (DOE, 1993c). The maximum detected values in OU 3 creek sediments (1.6 mg/kg and 1.4 mg/kg in IHSSs 200 and 202, respectively) were similar or less than background creek maximums (1.3 mg/kg and 2 mg/kg). Mean concentrations of beryllium in OU 3 reservoir sediments (0.9 mg/kg and 1.1 mg/kg in IHSSs 200 and 202, respectively) were less than reservoir benchmark means (range: 3.9 to 9.3 mg/kg).

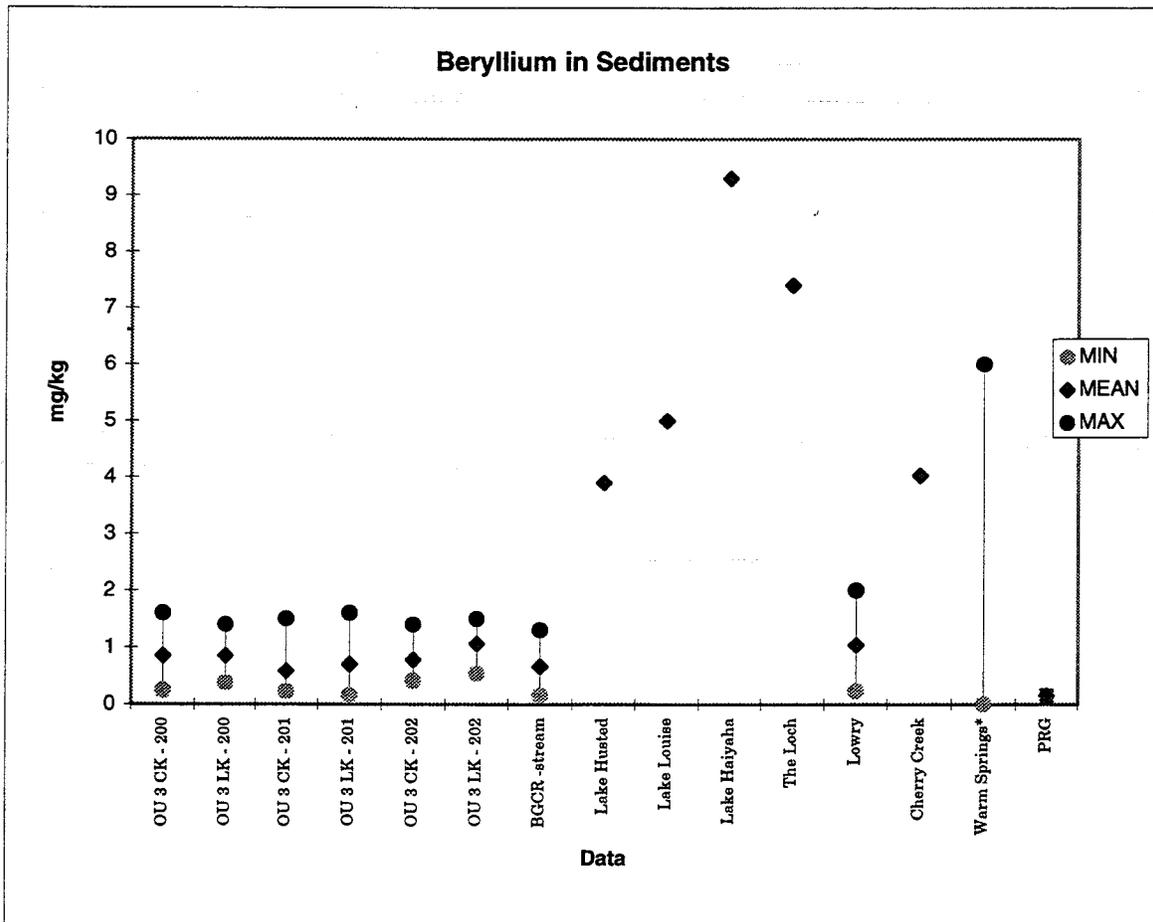
The range of beryllium concentrations for various sources is depicted in Figure 5-2. These sources include Superfund sites, background ranges, benchmark ranges, and the OU 3 data. Concentrations of beryllium in OU 3 sediments are below the mean concentrations in other Superfund sites and are comparable to background levels. Additionally, the concentrations of beryllium in OU 3 sediments are consistent; there are no apparent spurious data that would suggest anomalous concentrations. The purpose of using information from contaminated sites in addition to nonimpacted sites is to place OU 3 levels in perspective with other investigated sites.

A single population was indicated according to the analysis using PROBLOT (Appendix G). Beryllium in sediments shows no difference in mean, standard deviation, and median values between the three IHSSs. Because of the single population and low concentrations, OU 3 beryllium concentrations were associated with the background population (Appendix G).

**BERYLLIUM IN SEDIMENTS**

(mg/kg)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3 CK - 200	0.24	0.85	1.6	0.38	Great Western Reservoir Surface Sediments (Creek) (OU 3 Database)
OU 3 LK - 200	0.37	0.85	1.4	0.27	Great Western Reservoir Surface Sediments (Lake) (OU 3 Database)
OU 3 CK - 201	0.22	0.58	1.5	0.31	Standley Lake Surface Sediments (Creek) (OU 3 Database)
OU 3 LK - 201	0.15	0.7	1.6	0.47	Standley Lake Surface Sediments (Lake) (OU 3 Database)
OU 3 CK - 202	0.41	0.78	1.4	0.54	Mower Reservoir Surface Sediments (Creek) (OU 3 Database)
OU 3 LK - 202	0.54	1.06	1.5	0.27	Mower Reservoir Surface Sediments (Lake) (OU 3 Database)
BGCR -stream	0.15	0.66	1.3	1.69	RFP Background Stream Sediments, BGCR (DOE, 1993c)
Lake Husted		3.9		1	Rocky Mountain National Park Surface Sediments (Heit et al., 1984)
Lake Louise		5		3	Rocky Mountain National Park Surface Sediments (Heit et al., 1984)
Lake Haiyaha		9.3		1.1	Rocky Mountain National Park Surface Sediments (Heit et al., 1984)
The Loch		7.4		1.3	Rocky Mountain National Park Surface Sediments (Heit et al., 1984)
Lowry	0.23	1.04	2	0.48	Lowry Landfill Background Stream Sediment OUs 2-5 Baseline Risk Assessment (EPA, 1992)
Cherry Creek		4.03			Cherry Creek Reservoir (CCBA, 1994)
Warm Springs*	0		6		Warm Springs Pond Superfund Site, Pond Bottom Sediments (EPA, 1988)
PRG		0.15			10 <sup>-6</sup> PRG level based on a residential soil scenario (EG&G, 1994a)



Notes: If blank, no data are available.

\*Indicates Superfund site.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 5-2  
BERYLLIUM IN SEDIMENTS**

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Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of beryllium concentrations, thus indicating a natural population. The maps show that the beryllium concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoirs (Appendix F).

Based on the comparison of data sets, the PROBLOT analysis, and the lack of discernible spatial trends, it has been determined that beryllium concentrations in OU 3 sediments are not significantly above background; therefore, beryllium has been eliminated as a COC in IHSSs 200 and 202. As discussed earlier, beryllium has been eliminated as a COC in IHSS 200 by the concentration-toxicity screen.

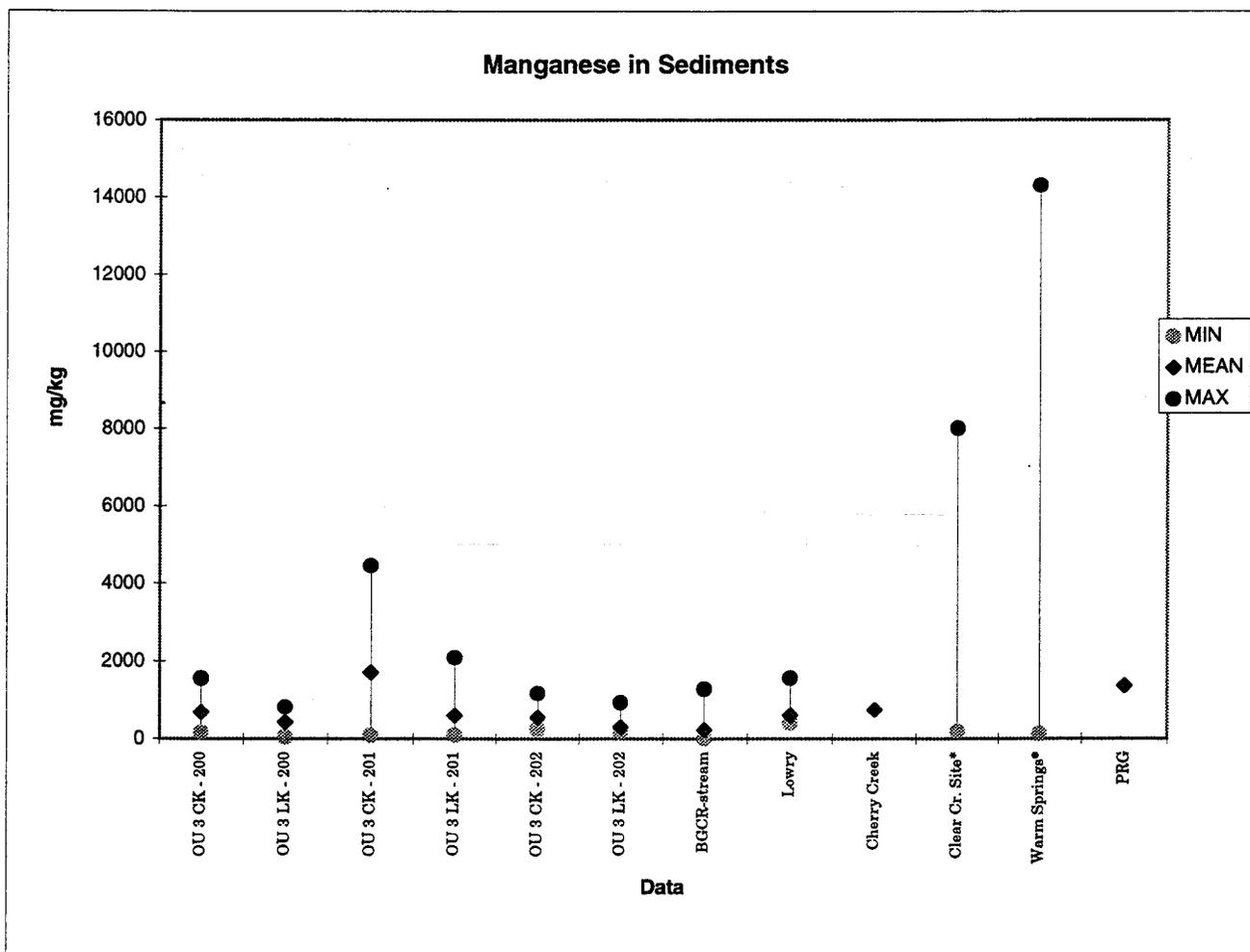
#### 5.6.1.3 Manganese

Manganese was screened out as a COC in IHSS 202 by the PRG screen (see Table 5-1). Mean concentrations of manganese in OU 3 creek sediments (684 mg/kg and 1,706 mg/kg in IHSSs 200 and 201, respectively) were greater than the mean concentrations given in the Lowry Landfill Superfund site background data set (605 mg/kg) (EPA, 1992) and the BGCR (228 mg/kg) (DOE, 1993c). The maximum detected creek values for OU 3 creek sediments (1,550 mg/kg and 4,450 mg/kg in IHSSs 200 and 201, respectively) were also greater than background creek maximums (1,280 mg/kg and 1,560 mg/kg). Mean concentrations of manganese in OU 3 reservoir sediments were 426 mg/kg and 595 mg/kg in IHSSs 200 and 201, respectively. Benchmark literature data were unavailable for reservoir sediment, although reservoir means were consistent with background means for creek sediments.

The range of manganese concentrations for various sources is depicted in Figure 5-3. These sources include Superfund sites, background ranges, and the OU 3 data. Concentrations of manganese in OU 3 sediments are below the mean concentrations in other Superfund sites and are comparable to levels in stream sediments data from the BGCR (DOE, 1993c). Additionally, the concentrations of manganese in OU 3 sediments are consistent; there are no apparent spurious data that would suggest anomalous concentrations. The purpose of using information

**MANGANESE IN SEDIMENTS**  
(mg/kg)

SEDIMENT DATA SET	MIN	MEAN	MAX	STD DEV	SOURCE/COMMENTS
OU 3 CK - 200	155	684	1550	526.56	Great Western Reservoir (Creek) OU 3 Database
OU 3 LK - 200	40.5	425.91	813	211.9	Great Western Reservoir (Lake) OU 3 Database
OU 3 CK - 201	83.5	1706.18	4450	1447.03	Standley Lake (Creek) OU 3 Database
OU 3 LK - 201	89.6	595.38	2080	592.16	Standley Lake (Lake) OU 3 Database
OU 3 CK - 202	238	548	1170	423.63	Mower Reservoir (Creek) OU 3 Database
OU 3 LK - 202	148	297.8	925	194.93	Mower Reservoir (Lake) OU 3 Database
BGCR-stream	9	228	1280	215	Background Geochemical Characterization Report (DOE, 1993c)
Lowry	402	605	1560	281	Lowry Landfill Background Stream Sediment OUs 2-5 Baseline Risk Assessment (EPA, 1992)
Cherry Creek		739			Cherry Creek Reservoir (CCBA, 1994)
Clear Cr. Site*	170		8000		Clear Creek Superfund Site (CDPHE, 1990)
Warm Springs*	120		14300		Warm Springs Pond Superfund Site, Pond Bottom Sediments (EPA, 1988)
PRG		1370			10 <sup>-6</sup> PRG level based on a residential soil scenario (EG&G, 1994a)



Notes: If blank, no data are available.

\*Indicates Superfund site.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 5-3**  
**MANGANESE IN SEDIMENTS**

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from contaminated sites in addition to nonimpacted sites is to place OU 3 levels in perspective with other investigated sites.

One population was identified in IHSS 200 and 201 by the PROBLOT analyses. The mean and median concentrations of manganese in IHSSs 200 and 201 are similar. However, the maximum concentration in IHSS 201 is three times higher than the maximum concentration in IHSS 200. This observation points to the input of Clear Creek into IHSS 201, a heavily mineralized drainage. Because Standley Lake receives approximately 90 percent of its water from Clear Creek, it is highly likely that the slightly elevated levels of manganese are attributable to this source (Appendix G).

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of manganese concentrations, thus indicating a natural population. The maps show that the manganese concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Concentration-depth profiles were analyzed for the deepest cores in each IHSS (see Figure 5-4). Manganese concentrations appear to be consistent throughout the depth of the core, with no trends or obvious data spikes indicating contamination.

Based on the comparison of data sets, the PROBLOT analysis, the lack of discernible spatial trends, and the core profiles, it has been determined that manganese concentrations in the reservoir and creek sediments are not significantly above background; therefore, manganese has been eliminated as a COC in IHSSs 200 and 201. This conclusion is supported by the Phase 1 Health Studies, which did not identify manganese as a material of concern (CDPHE, 1991b).

#### 5.6.1.4 Uranium<sup>235</sup>

Uranium<sup>235</sup> was screened out as a COC in IHSS 202 by the PRG screen. Mean activities of <sup>235</sup>U in OU 3 creek sediment (0.07 pCi/g and 0.08 pCi/g in IHSSs 200 and 201, respectively) were less than the mean plus two standard deviations (0.16 pCi/g) as given in the BGCR (DOE,

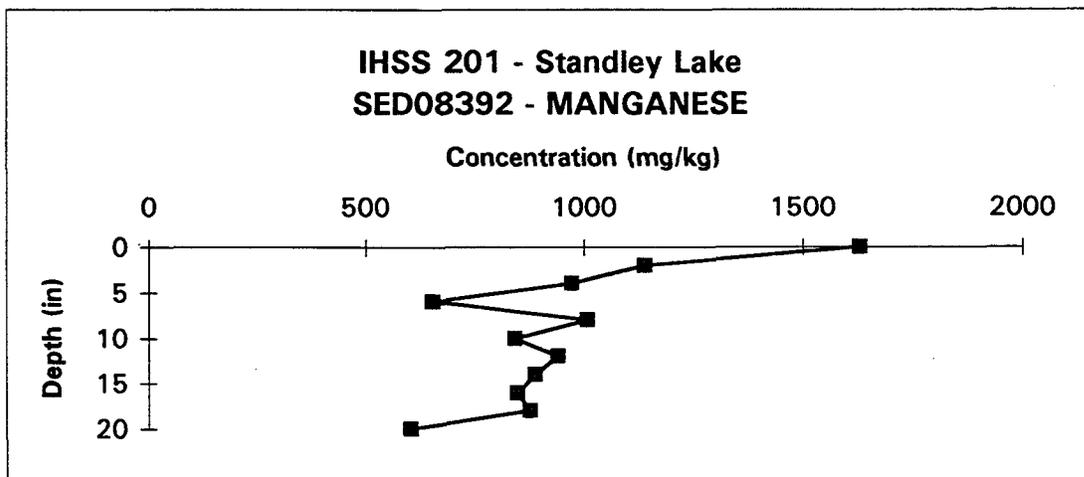
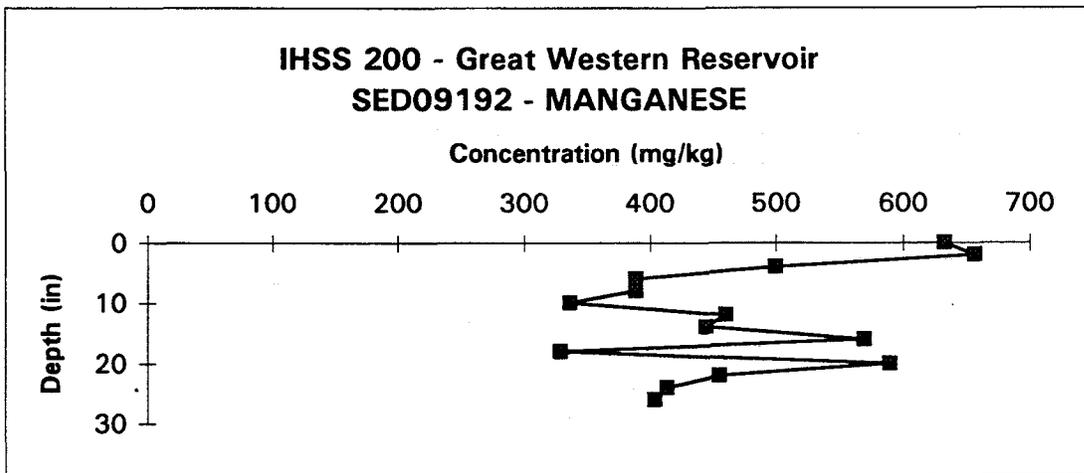
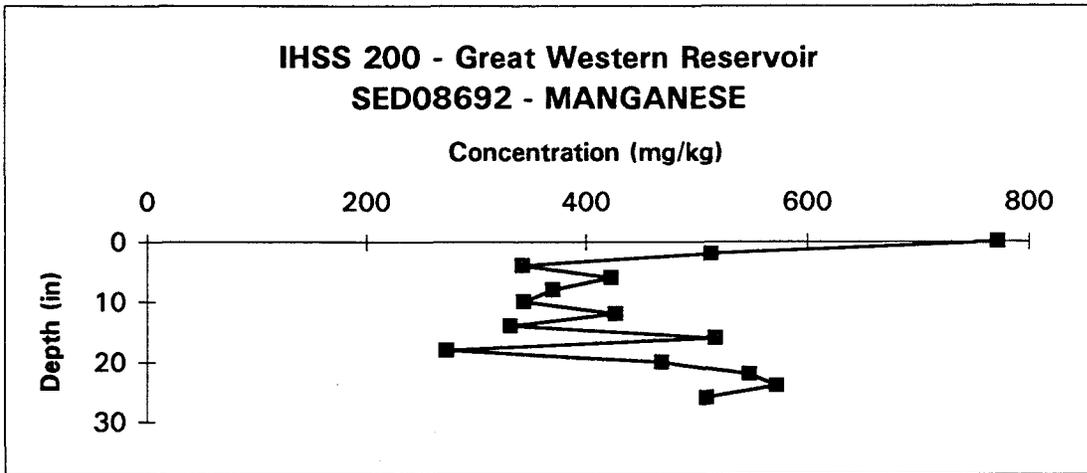
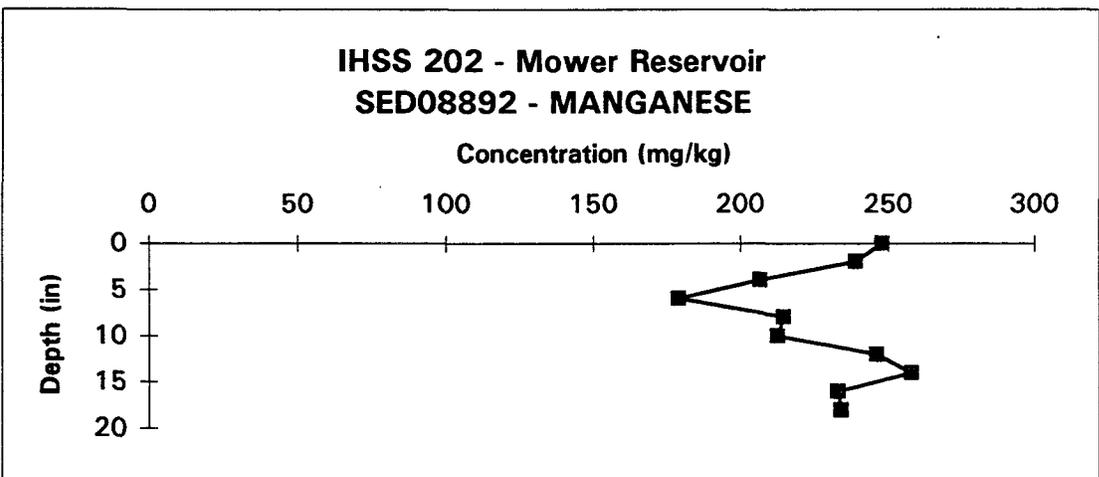
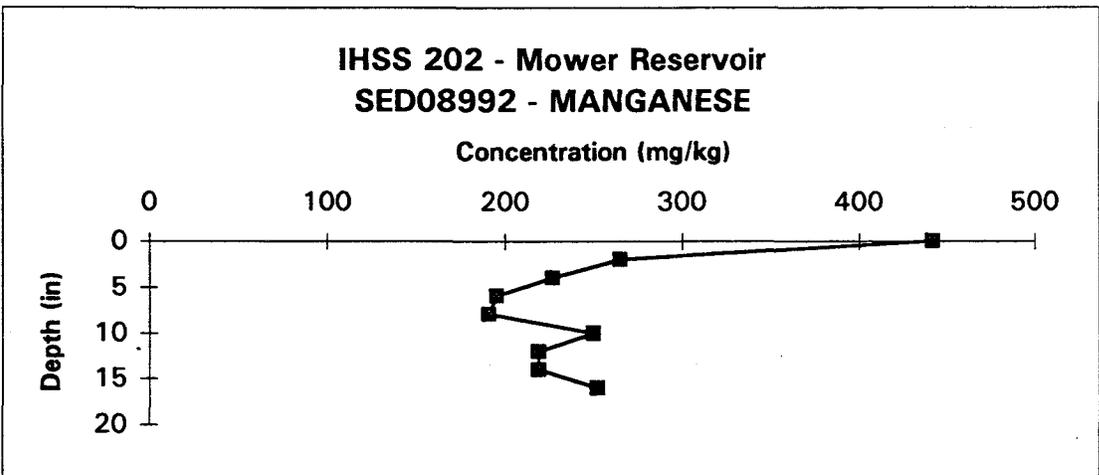
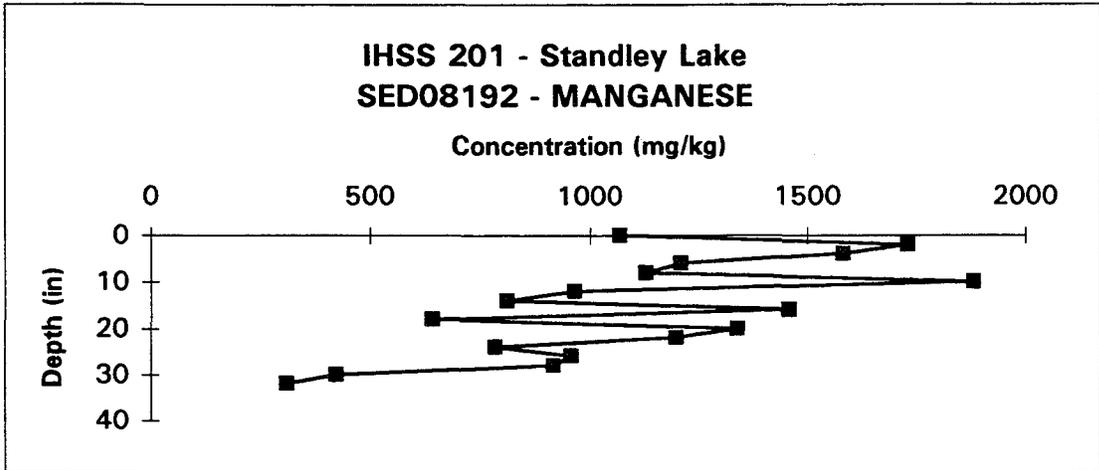


Figure 5-4



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1993c). No data were available from the Lowry Landfill Superfund site background data set (EPA, 1992) for  $^{235}\text{U}$ . The maximum detected values in OU 3 creek sediments (0.2 pCi/g in both IHSSs 200 and 201, respectively) were consistent with the maximum background values for creek sediments. Mean activities in OU 3 reservoir sediments were 0.07 pCi/g and 0.05 pCi/g in IHSSs 200 and 201, respectively. Benchmark literature data were only available for total uranium, and ranged from 0.9 to 226.4 pCi/g. Mean activities of  $^{235}\text{U}$  in OU 3 reservoir sediments fell within this range. Mean activities in reservoir sediment were consistent with the background mean (0.06 pCi/g) in IHSS 201 and below the background mean in IHSS 200. Because only total uranium activities were available for reservoir sediments, and overall data sets were few in number, a figure depicting  $^{235}\text{U}$  activity ranges was not generated.

Based on the PROBLOT analysis, one population was identified in each of the three IHSSs. With the exception of the single sample in IHSS 200 that exceeded the 95th percentile, the  $^{235}\text{U}$  activities at OU 3 represent a single site-specific background population. The sample location (SED06692) also showed exceedances of the 95th percentile for  $^{233}\text{U}$  and  $^{238}\text{U}$ , suggesting that the area around SED06692 may represent natural uranium mineralization. A single population is indicated based on means, medians, and maximum values (Appendix G).

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of  $^{235}\text{U}$  activities, thus indicating a natural population. The maps show that the  $^{235}\text{U}$  concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Based on the comparison to background, the PROBLOT analysis, and the lack of discernible spatial trends, it has been determined that  $^{235}\text{U}$  activities in OU 3 sediments are not significantly above background levels; therefore,  $^{235}\text{U}$  has been eliminated as a COC in IHSSs 200 and 201.

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## 5.6.2 Weight-of-Evidence Evaluations for Chemicals Without Toxicity Factors (Surface Sediments)

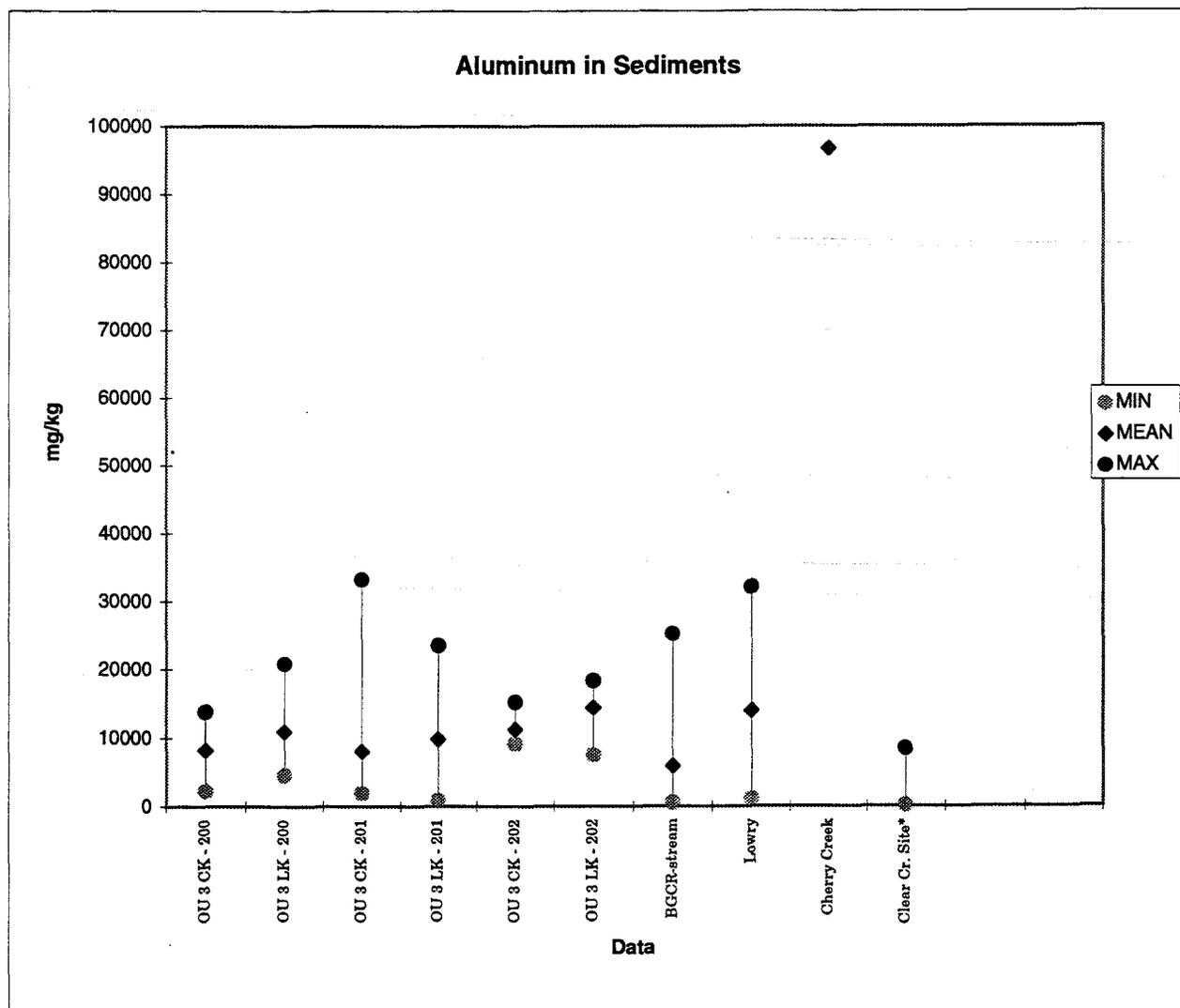
### 5.6.2.1 Aluminum

Mean aluminum concentrations in OU 3 creek sediment (8,234 mg/kg, 8,031 mg/kg, and 11,228 mg/kg in IHSSs 200, 201, and 202, respectively) were less than the mean plus two standard deviations (15,714 mg/kg) given in the BGCR (DOE, 1993c) and below the Lowry Landfill Superfund site background mean (13,959 mg/kg) (EPA, 1992). Maximum concentrations in OU 3 creek sediments in IHSSs 200 and 202 (13,800 mg/kg and 15,200 mg/kg, respectively) were less than the maximum concentration (25,200 mg/kg) given in the BGCR (DOE, 1993c) and the Lowry Landfill Superfund site background maximum concentration (32,100 mg/kg) (EPA, 1992). The maximum detected value in IHSS 201 was 33,200 mg/kg at sample location SED00992; the next highest value in IHSS 201 was 12,800 mg/kg. No elevated values were seen around sample location SED00992. Mean concentrations in OU 3 reservoir sediments were 10,911 mg/kg, 9,835 mg/kg, and 14,370 mg/kg in IHSSs 200, 201, and 202, respectively. The maximum concentrations of aluminum in surface sediments were less than Cherry Creek Reservoir (96,700 mg/kg), the only available reservoir benchmark data set. Reservoir means were less than or similar to the available background creek data. Maximum concentrations of aluminum in OU 3 reservoir sediments (20,800 mg/kg, 23,500 mg/kg, and 18,300 mg/kg in IHSSs 200, 201, and 202, respectively) were less than the maximum concentrations given in the BGCR (DOE, 1993c).

The range of aluminum concentrations for various sources is depicted in Figure 5-5. These sources include Superfund sites, background ranges, benchmark literature ranges, and OU 3 data. OU 3 aluminum levels appear to be comparable to background levels. Additionally, the concentrations of aluminum in OU 3 sediments are consistent; there are no apparent spurious data that would suggest anomalous concentrations. The purpose of using information from contaminated sites in addition to nonimpacted sites is to place OU 3 levels in perspective with other investigated sites.

**ALUMINUM IN SEDIMENTS**  
(mg/kg)

SEDIMENT DATA SET	MIN	MEAN	MAX	STD DEV	SOURCE/COMMENTS
OU 3 CK - 200	2220	8234	13800	3848	Great Western Reservoir (Creek) OU 3 Database
OU 3 LK - 200	4530	10911	20800	4212	Great Western Reservoir (Lake) OU 3 Database
OU 3 CK - 201	1900	8031	33200	7958	Standley Lake (Creek) OU 3 Database
OU 3 LK - 201	852	9835	23500	6623	Standley Lake (Lake) OU 3 Database
OU 3 CK - 202	9110	11228	15200	2718	Mower Reservoir (Creek) OU 3 Database
OU 3 LK - 202	7480	14370	18300	3096	Mower Reservoir (Lake) OU 3 Database
BGCR-stream	549	5888	25200	4913	Background Geochemical Characterization Report (DOE, 1993c)
Lowry	1105	13959	32100	7081	Lowry Landfill Background Stream Sediment OUs 2-5 Baseline Risk Assessment (EPA, 1992)
Cherry Creek		96700			Cherry Creek Reservoir (CCBA, 1994)
Clear Cr. Site*	84		8400		Clear Creek Superfund Site (CDPHE, 1990)



Notes: If blank, no data are available.

\*Indicates Superfund site.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 5-5**  
**ALUMINUM IN SEDIMENTS**

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Based on the PROBLOT analyses, one population was identified in IHSS 200 and 201. Two populations were noted in IHSS 202. The two populations in IHSS 202 are most likely the result of natural physical processes occurring in the reservoir. Because the concentration data within IHSS 202 are similar to the data in IHSS 200 and 201, it is most probable that the aluminum concentrations in IHSS 202 sediments represent natural variability within background levels (Appendix G).

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of aluminum concentrations, thus indicating a natural population. Hem stated that "Aluminum is the third most abundant element in the earth's outer crust..." and that "Aluminum occurs in substantial amounts in many silicate igneous rock minerals..." (Hem, 1985). The maps show that the aluminum concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Based on the similarity of the data sets, the PROBLOT analysis, and the lack of discernible spatial trends, it has been determined that aluminum concentrations in OU 3 sediments are not significantly above background; therefore, aluminum has been eliminated as a COC in all three IHSSs. This conclusion is supported by the Phase 1 Health Studies, which did not identify aluminum as a material of concern (CDPHE, 1991b).

#### 5.6.2.2 Cesium

Cesium was not listed as an analyte in the OU 3 workplan (DOE, 1992) and was used to meet data quality objectives in a sediment age-dating task. However, cesium is evaluated in this subsection because of the availability of useable data. Cesium was not detected in creek sediment in IHSS 200. Mean concentrations of cesium in OU 3 creek sediments were 40.9 mg/kg and 33.1 mg/kg in IHSSs 201 and 202, respectively. These values were less than the mean given in the BGCR (DOE, 1993c) – 69.3 mg/kg. The maximum detected cesium concentrations in IHSSs 201 and 202 (19.9 mg/kg and 2.0 mg/kg, respectively) were less than the creek maximum (157 mg/kg). No data for cesium were available from the Lowry Landfill Superfund site background data set (EPA, 1992). It is interesting that the mean concentrations are higher than the maximum concentrations in OU 3 sediments for cesium. This is an artifact

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of how the mean concentrations were calculated. One-half of the reported values for non-detects were averaged with all detects. Because cesium has several high non-detects, the calculated mean is higher than the maximum detected concentrations. Mean concentrations of cesium in OU 3 reservoir sediments were 36.0 mg/kg and 14.7 mg/kg in IHSSs 200 and 202, respectively. Cesium was not detected in reservoir sediments in IHSS 201. Reservoir benchmark literature data were unavailable for cesium. Mean concentrations of cesium in OU 3 reservoir sediments were below the mean given in the BGCR (DOE, 1993c). Maximum concentrations of cesium in OU 3 reservoir sediments in IHSSs 200 and 202 (29.7 mg/kg and 69.8 mg/kg, respectively) were below the maximum given in the BGCR (DOE, 1993c). Because of low mean concentrations, a figure depicting cesium ranges for various sources was not generated.

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of cesium concentrations, thus indicating a natural population. The maps show that the cesium concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Based on the similarity of the data sets and the lack of discernible spatial trends, it has been determined that cesium concentrations in OU 3 sediments are not significantly above background; therefore, cesium has been eliminated as a COC for all three IHSSs. This conclusion is supported by the Phase 1 Health Studies, which did not identify cesium as a material of concern (CDPHE, 1991b).

#### 5.6.2.3 Cobalt

Mean concentrations of cobalt in OU 3 creek sediments (11.3 mg/kg, 7.9 mg/kg, and 7.8 mg/kg in IHSSs 200, 201, and 202, respectively) were less than the mean plus two standard deviations (11.6 mg/kg) given in the BGCR (DOE, 1993c) or the Lowry Landfill Superfund site background mean (9.2 mg/kg) (EPA, 1992). OU 3 maximum concentrations (23.3 mg/kg, 10.9 mg/kg, and 9.6 mg/kg in IHSSs 200, 201, and 202, respectively) were similar to the maximum concentration (15 mg/kg) reported in the BGCR (DOE, 1993c) and the maximum concentration (14 mg/kg) reported in the Lowry Landfill Superfund site background

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data set (EPA, 1992). Mean concentrations of cobalt in OU 3 reservoir sediments (8.7 mg/kg, 7.1 mg/kg, and 8.4 mg/kg in IHSSs 200, 201, and 202, respectively) were less than the mean concentration of cobalt (21.3 mg/kg) in Cherry Creek Reservoir, the only available reservoir benchmark literature data set. Mean concentrations of cobalt in OU 3 reservoir sediments were less than the Lowry Landfill Superfund site background mean (9.2 mg/kg) (EPA, 1992) and less than the mean plus two standard deviations (11.6 mg/kg) given in the BGCR (DOE, 1993c). Mean concentrations of cobalt in OU 3 reservoir sediments were lower than or similar to the available background creek data. Maximum concentrations of cobalt in OU 3 reservoir sediments (13.5 mg/kg, 13.2 mg/kg, and 15.3 mg/kg in IHSSs 200, 201, and 202, respectively) were less than or similar to the background creek maximums.

The range of cobalt concentrations for various sources is depicted in Figure 5-6. These sources include background ranges and OU 3 data. OU 3 cobalt levels fall within range of the background sources. Additionally, the concentrations of cobalt in OU 3 sediments are consistent; there are no apparent spurious data that would suggest anomalous concentrations.

Based on the PROBLOT analysis, one population was identified for cobalt in each IHSS. Cobalt concentrations are relatively the same as nickel (screened out by the concentration-toxicity step) concentrations in sediments (Deer et al., 1971). This close association is retained in OU 3 sediments and suggests that the cobalt population is naturally occurring (Appendix G).

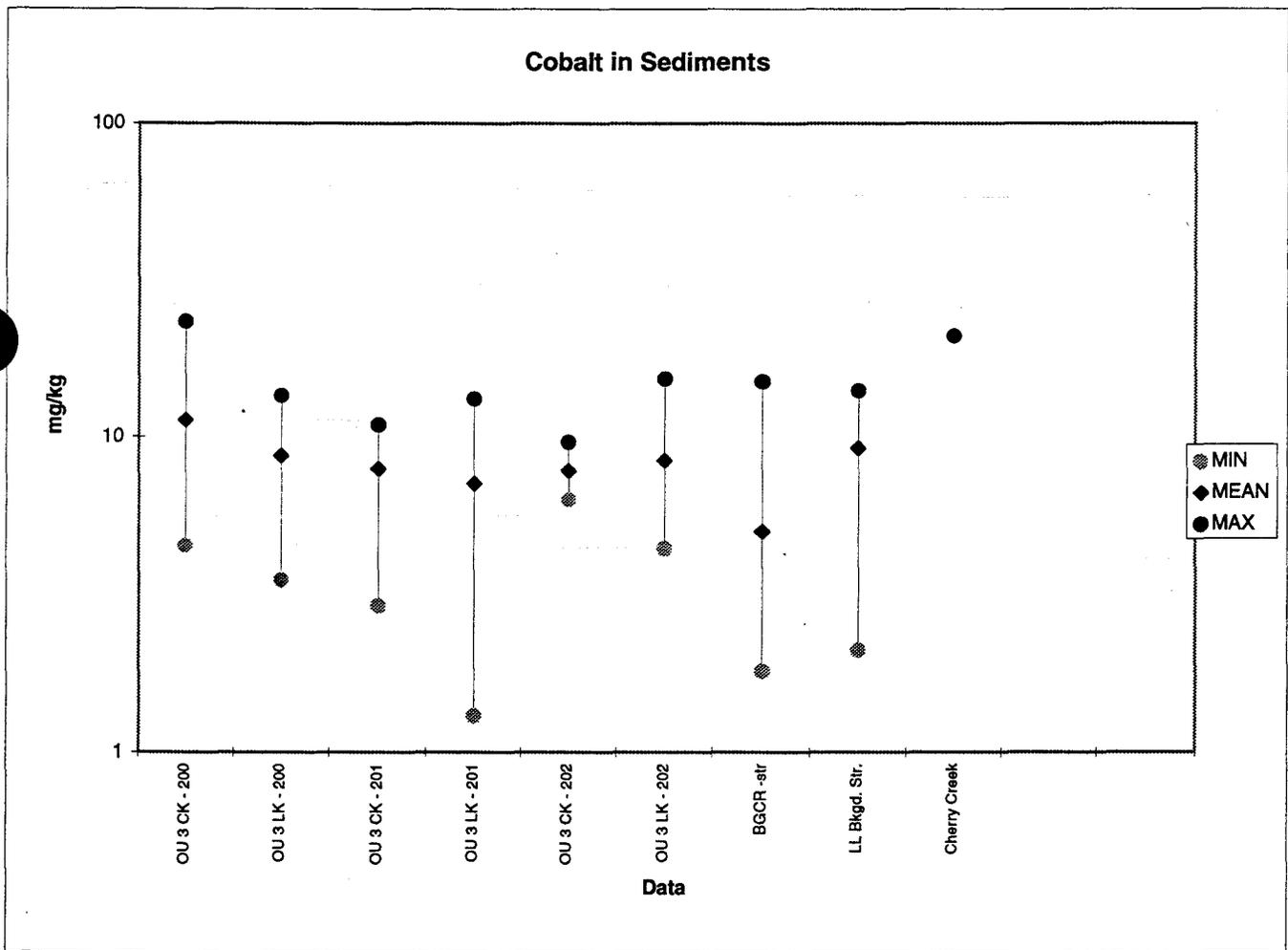
Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of cobalt concentrations, thus indicating a natural population. The maps show that the cobalt concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Based on the similarity of the data sets, the PROBLOT analysis, and the lack of discernible spatial trends, it has been determined that cobalt concentrations in OU 3 sediments are not significantly above background; therefore, cobalt has been eliminated as a COC for all three IHSSs. This conclusion is supported by the Phase 1 Health Studies, which did not identify cobalt as a material of concern (CDPHE, 1991b).

**COBALT IN SEDIMENTS**

(mg/kg)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3 CK - 200	4.5	11.3	23.3	6	Great Western Reservoir Surface Sediments (Creek) OU 3 Database
OU 3 LK - 200	3.5	8.7	13.5	2	Great Western Reservoir Surface Sediments (Lake) OU 3 Database
OU 3 CK - 201	2.9	7.9	10.9	2.2	Standley Lake Surface Sediments (Creek) OU 3 Database
OU 3 LK - 201	1.3	7.1	13.2	3.5	Standley Lake Surface Sediments (Lake) OU 3 Database
OU 3 CK - 202	6.3	7.8	9.6	1.4	Mower Reservoir Surface Sediments (Creek) OU 3 Database
OU 3 LK - 202	4.4	8.4	15.3	2.6	Mower Reservoir Surface Sediments (Lake) OU 3 Database
BGCR -stream	1.8	5	15	3.3	RFP Background Stream Sediments, BGCR (DOE, 1993c)
Lowry	2.1	9.2	14	2.9	Lowry Landfill Background Stream Sediment OUs 2-5 Baseline Risk Assessment (EPA, 1992)
Cherry Creek		21.3			Cherry Creek Reservoir (CCBA, 1994)



Notes: If blank, no data are available.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 5-6  
COBALT IN SEDIMENTS**

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#### 5.6.2.4 Lead

Mean concentrations of lead in OU 3 creek sediments (18.5 mg/kg, 38.5 mg/kg, 16.8 mg/kg in IHSSs 200, 201 and 202, respectively) were less than the mean plus two standard deviations as given in the BGCR (DOE, 1993c) and the background data set from the Lowry Landfill Superfund site (91 mg/kg and 162 mg/kg, respectively) (EPA, 1992). The maximum concentrations in OU 3 creek sediments (36.2 mg/kg, 91.4 mg/kg and 21.6 mg/kg in IHSSs 200, 201, and 202, respectively) were less than the maximum concentrations given in the BGCR (DOE, 1993c) and the background data set from the Lowry Landfill Superfund site (244 mg/kg and 380 mg/kg, respectively) (EPA, 1992). Mean concentrations of lead in OU 3 reservoir sediments were 31.4 mg/kg, 63.8 mg/kg, and 30.0 mg/kg in IHSSs 200, 201, and 202, respectively. Means in IHSSs 200 and 202 were less than Rocky Mountain National Park reservoir sediment means (14 mg/kg to 43 mg/kg) and Cherry Creek reservoir (55 mg/kg).

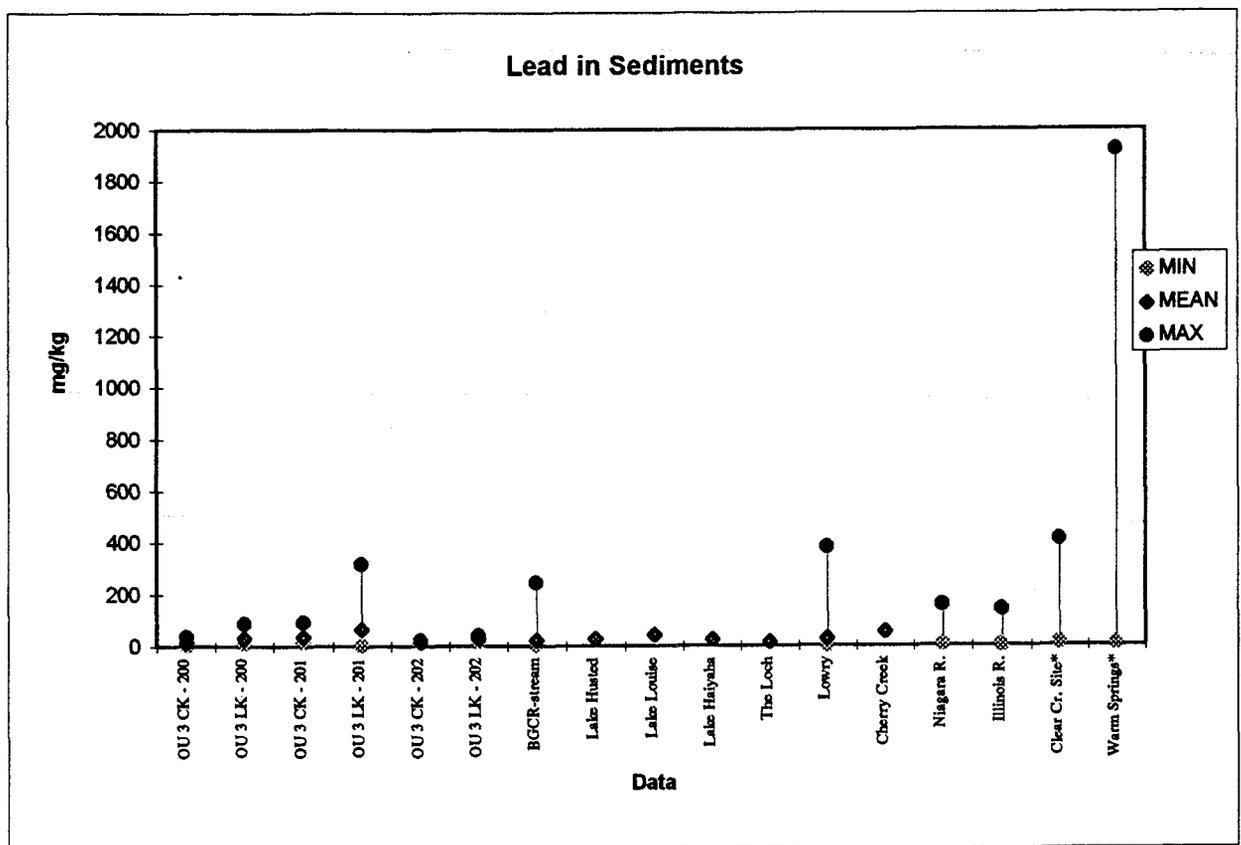
One anomalous reservoir sediment value for lead was approximately two-thirds greater than the next highest value. This location (SED09592) was sampled on two other dates. Results for SED09592 were 24.9 mg/kg, 36.6 mg/kg, and 317 mg/kg. Without the outlier of 317 mg/kg, the reservoir sediment mean in IHSS 201 was 57.7 mg/kg, similar to the mean in Cherry Creek Reservoir.

The range of lead concentrations for various sources is depicted in Figure 5-7. These sources include Superfund sites, industrial sites, background ranges, benchmark literature ranges, and the OU 3 data. Concentrations of lead in OU 3 sediments are below the mean concentrations in other Superfund sites and are comparable to background levels. Additionally, the concentrations of lead in OU 3 sediments are consistent; there are no apparent spurious data that would suggest anomalous concentrations. The purpose of using information from contaminated sites in addition to nonimpacted sites is to place OU 3 levels in perspective with other investigated sites.

One population was identified based on the PROBLOT analysis in each of the three IHSSs. The maximum concentration of lead occurs in IHSS 201. This maximum may be attributable to the mining wastes originating upstream in Clear Creek, which is additionally a partial source for

**LEAD IN SEDIMENTS**  
(mg/kg)

SEDIMENT DATA SET	MIN	MEAN	MAX	STD DEV	SOURCE/COMMENTS
OU 3 CK - 200	5.3	18.51	36.2	9.36	Great Western Reservoir (Creek) OU 3 Database
OU 3 LK - 200	13	31.37	88.2	18.61	Great Western Reservoir (Lake) OU 3 Database
OU 3 CK - 201	17.2	38.45	91.4	21.06	Standley Lake (Creek) OU 3 Database
OU 3 LK - 201	2.9	63.75	317	67.11	Standley Lake (Lake) OU 3 Database
OU 3 CK - 202	12.3	16.78	21.6	3.81	Mower Reservoir (Creek) OU 3 Database
OU 3 LK - 202	14.5	29.99	40.8	7.75	Mower Reservoir (Lake) OU 3 Database
BGCR-stream	2.1	22.02	244	36.79	Background Geochemical Characterization Report (DOE, 1993c)
Lake Husted		28		2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lake Louise		43		0	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lake Haiyaha		26		2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
The Loch		14		2	Rocky Mountain National Park Lake Surface Sediment (Heit et al., 1984)
Lowry	0.001	28	380	67	Lowry Landfill Background Stream Sediment OUs 2-5 Baseline Risk Assessment (EPA, 1992)
Cherry Creek		55			Cherry Creek Reservoir Surface Sediment (CCBA, 1994)
Niagara R.	6		157		Fergusson, 1990 (polluted)
Illinois R.	3		140		Fergusson, 1990 (near municipal/industrial)
Clear Cr. Site*	11		410		Clear Creek Superfund Site (CDPHE, 1990)
Warm Springs*	8		1920		Warm Springs Pond Superfund Site (Range) (EPA, 1988)



Notes: If blank, no data are available.

\*Indicates Superfund site.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 5-7**  
**LEAD IN SEDIMENTS**

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IHSS 200. Only one sample exceeded the 95th percentile as defined by PROBLOT. This sample is located in the deepest portion of the reservoir and suggests natural accumulation of fine-grained material. Contamination is not indicated because metals adsorb more readily to finer-grained material (Davis and Kent, 1990; Pankow, 1991) (Appendix G).

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of lead concentrations, thus indicating a natural population. The maps show that the lead concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Based on the similarity of the data sets, PROBLOT analysis, and no discernible spatial trends, it has been determined that lead is not significantly above background; therefore, lead has been eliminated as a COC for all three IHSSs.

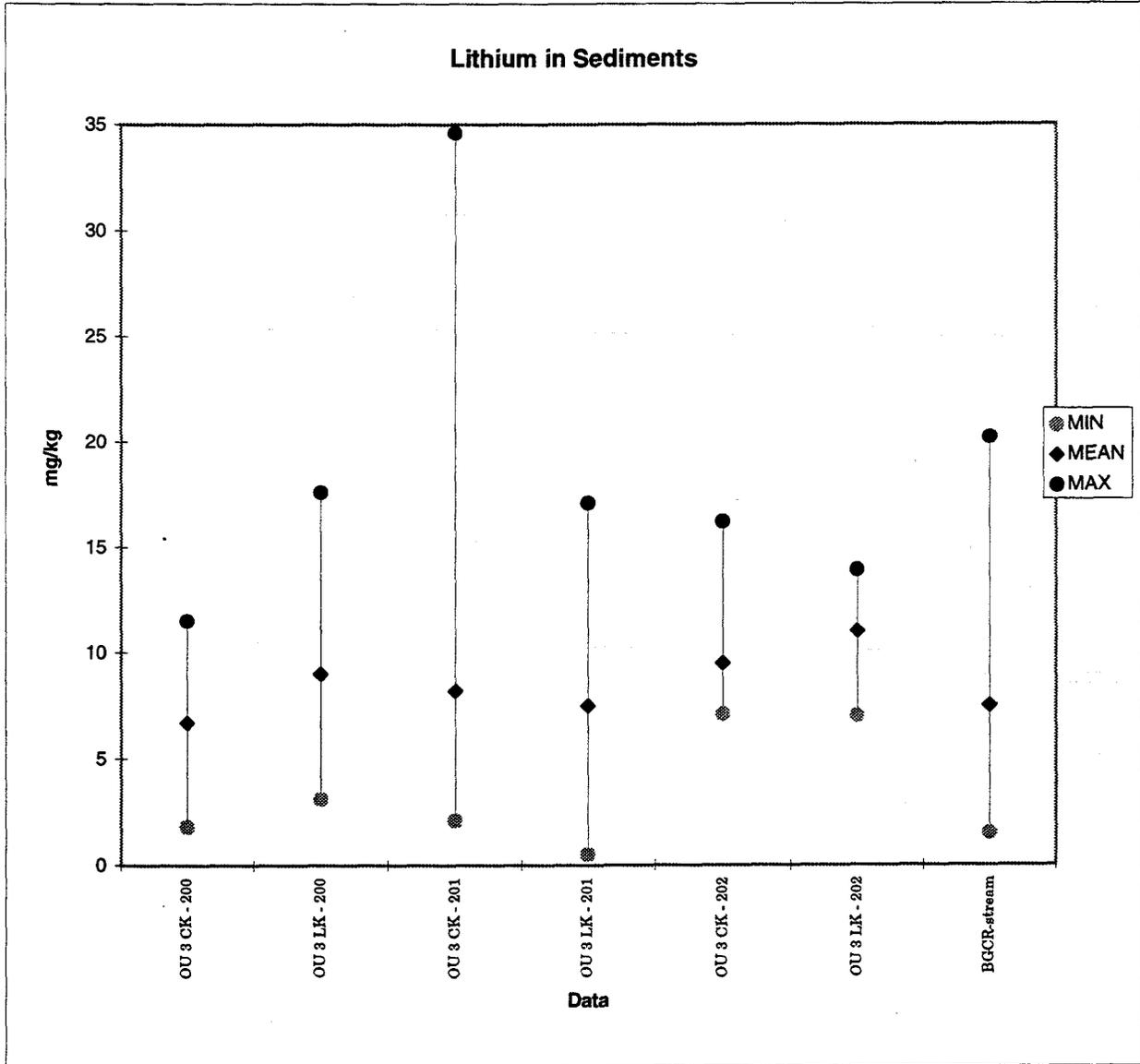
#### 5.6.2.5 Lithium

Mean lithium concentrations in OU 3 creek sediment (6.7 mg/kg, 8.2 mg/kg, 9.5 mg/kg in IHSSs 200, 201 and 202, respectively) were less than mean plus two standard deviations (18 mg/kg) in the BGCR (DOE, 1993c). No data were available for lithium in the Lowry Landfill Superfund site background data set (EPA, 1992). The maximum detected creek values in IHSSs 200 and 202 (11.5 mg/kg and 16.2 mg/kg) were less than the creek maximum (20.2 mg/kg). The maximum value in IHSS 201 (34.6 mg/kg) at sample location SED00992 was approximately three times the next highest reported value (13.1 mg/kg). This maximum appears to be an outlier, because concentrations near SED00992 were not elevated. OU 3 reservoir sediment means were 9.0 mg/kg, 7.5 mg/kg, and 11.0 mg/kg in IHSSs 200, 201, and 202, respectively. Reservoir benchmark literature data were unavailable for lithium. OU 3 reservoir sediment lithium means were less than the mean plus two standard deviations as given in the BGCR (DOE, 1993c). OU 3 reservoir maximums (17.6 mg/kg, 17.1 mg/kg, 13.9 mg/kg) were below the background creek maximum.

The range of lithium concentrations for various sources is depicted in Figure 5-8. These sources include the BGCR data (DOE, 1993c) and OU 3 data. Concentrations of lithium in

**LITHIUM IN SEDIMENTS**  
(mg/kg)

SEDIMENT DATA SET	MIN	MEAN	MAX	STD DEV	SOURCE/COMMENTS
OU 3 CK - 200	1.8	6.7	11.5	3.2	Great Western Reservoir (Creek) OU 3 Database
OU 3 LK - 200	3.1	9	17.6	3.1	Great Western Reservoir (Lake) OU 3 Database
OU 3 CK - 201	2.1	8.2	34.6	8.3	Standley Lake (Creek) OU 3 Database
OU 3 LK - 201	0.5	7.5	17.1	4.8	Standley Lake (Lake) OU 3 Database
OU 3 CK - 202	7.1	9.5	16.2	4.5	Mower Reservoir (Creek) OU 3 Database
OU 3 LK - 202	7	11	13.9	2.4	Mower Reservoir (Lake) OU 3 Database
BGCR-stream	1.5	7.5	20.2	5.3	Background Geochemical Characterization Report (DOE, 1993c)



Notes: If blank, no data are available.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 5-8**  
**LITHIUM IN SEDIMENTS**

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OU 3 sediments are consistent with the mean concentration reported in the BGCR (DOE, 1993c).

Based on the PROBLOT analyses, there appears to be only one population for each of the three IHSSs, suggesting a common background population. Similar to other metals, the maximum lithium concentration is highest in IHSS 201. This may be attributable to the highly mineralized sediments feeding IHSS 201 from Clear Creek (Appendix G).

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of lithium concentrations, thus indicating a natural population. The maps show that the lithium concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Based on the similarity of the data sets, the PROBLOT analysis, and the lack of discernible spatial trends, it has been determined that lithium concentrations in OU 3 sediments are not significantly above background; therefore, lithium has been eliminated as a COC in all three IHSSs. This conclusion is supported by the Phase 1 Health Studies, which did not identify lithium as a material of concern (CDPHE, 1991b).

#### 5.6.2.6 Silicon

Mean concentrations of silicon in IHSS 200 (459 mg/kg) were less than the mean plus two standard deviations (1,057 mg/kg) given in the BGCR (DOE, 1993c). The maximum concentration of silicon (1,450 mg/kg) given in the BGCR (DOE, 1993c) was greater than the maximum detected concentration in IHSS 200 (1,020 mg/kg). No data were available for silicon in the Lowry Landfill Superfund site background data set (EPA, 1992). Mean and maximum concentrations of silicon in IHSS 201 (1,168 mg/kg and 3,290 mg/kg, respectively) were slightly higher than the concentrations given in the BGCR (DOE, 1993c). This maximum concentration of 3,290 mg/kg in IHSS 201 was more than twice the next highest value (1,590 mg/kg). Only one sample was taken in creek sediments in IHSS 202 (412 mg/kg), which was less than the mean plus two standard deviations (1,057 mg/kg) given in the BGCR (DOE, 1993c). Mean concentrations of silicon in OU 3 reservoir sediments were 238 mg/kg

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and 197 mg/kg in IHSSs 200 and 201, respectively. Silicon was not analyzed for in reservoir sediments in IHSS 202. No reservoir benchmark data were available for comparison. Mean concentrations of silicon in OU 3 reservoir sediments were lower than the available background creek data. Maximum concentrations in OU 3 reservoir sediments (650 mg/kg and 396 mg/kg in IHSSs 200 and 201, respectively) were less than the available background creek data.

The range of silicon concentrations for various sources is depicted in Figure 5-9. These sources include the BGCR (DOE, 1993c) data and OU 3 data. OU 3 silicon levels are within the range of the BGCR (DOE, 1993c) data. Additionally, the concentrations of silica in OU 3 sediments are consistent; there are no apparent spurious data that would suggest anomalous concentrations. The maximum concentration in creek sediment in IHSS 201 appears to be an outlier. The next highest value in creek sediment in IHSS 201 is comparable to the BGCR (DOE, 1993c) maximum.

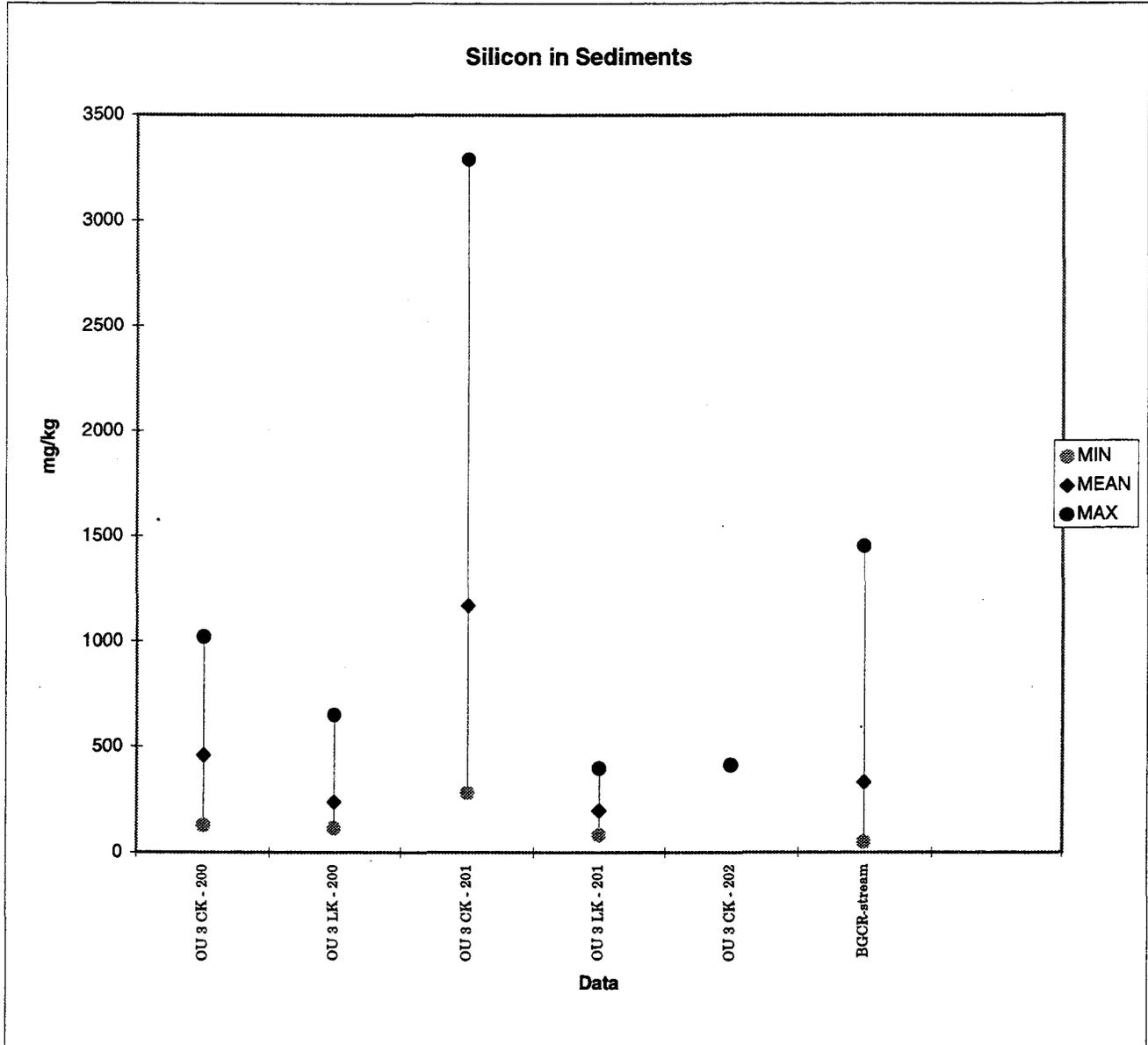
In IHSSs 200 and 201, one population was identified based on the probability plots. As mentioned above, only one sample was analyzed for in IHSS 202; therefore, no PROBLOT analysis was performed. Considering the abundance of silica in quartz and other minerals contained in sediments, silica concentrations in OU 3 sediments are low. The maximum concentrations of silicon are less than 1 percent compared to an average crustal abundance of approximately 28 percent (ref).

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of silicon concentrations, thus indicating a natural population. The maps show that the silica concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Based on the similarity of the data sets, the nontoxic effects, the PROBLOT analysis, and the lack of discernible spatial trends, it has been determined that silicon is not significantly above background and has been eliminated as a COC for all three IHSSs. This conclusion is supported by the Phase 1 Health Studies, which did not identify silicon as a material of concern (CDPHE, 1991b).

**SILICON IN SEDIMENTS**  
(mg/kg)

SEDIMENT DATA SET	MIN	MEAN	MAX	STD DEV	SOURCE
OU 3 CK - 200	128	459	1020	365	Great Western Reservoir (Creek) OU 3 Database
OU 3 LK - 200	115	238	650	125	Great Western Reservoir (Lake) OU 3 Database
OU 3 CK - 201	281	1168	3290	937	Standley Lake (Creek) OU 3 Database
OU 3 LK - 201	82	197	396	79	Standley Lake (Lake) OU 3 Database
OU 3 CK - 202	412	412	412		Mower Reservoir (Creek) OU 3 Database
BGCR-stream	48	332	1450	362	Background Geochemical Characterization Report (DOE, 1993c)



Notes: If blank, no data are available.

OU 3 CK-200 = Creek sediment data in IHSS 200.

OU 3 LK-200 = Lake sediment data in IHSS 200.

**Figure 5-9**  
**SILICON IN SEDIMENTS**

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#### 5.6.2.7 Thallium

Because a PRG was unavailable for comparison, thallium is being discussed in this section.

Thallium was not detected in creek sediments in IHSS 200, nor in reservoir sediments in IHSSs 201 and 202. Detection frequencies in the remaining subsets (creek sediments in IHSSs 201 and 202, and reservoir sediments in IHSS 200) were low (14, 25, and 3, respectively).

Mean concentrations of thallium in OU 3 creek sediments (0.3 mg/kg and 0.2 mg/kg in IHSSs 201 and 202, respectively) and maximum concentrations (0.4 mg/kg and 0.3 mg/kg in IHSSs 201 and 202, respectively) were consistent with the mean and maximum given in the BGCR (mean = 0.3 mg/kg, maximum = 0.4 mg/kg) (DOE, 1993c). OU 3 means and maximums were less than those given in the Lowry Landfill Superfund site background data set (mean = 1.6 mg/kg and maximum = 3.7 mg/kg) (EPA, 1992). For 36 samples in IHSS 201, there was only one detection in reservoir sediment at location SED13592. Spatial analysis of IHSS 200 did not show elevated values around that sample point. Because of the low detection frequencies and the low mean concentrations, a figure depicting thallium ranges for various sources was not generated.

Spatially, there were no discernible patterns in OU 3 sediments, despite the high variability of thallium concentrations, thus indicating a natural population. The maps show that the thallium concentrations tend to be randomly distributed along the shoreline, in the streams, and in the middle areas of the reservoir (Appendix F).

Based on the comparison of the data sets, the single detect in reservoir sediment, and the lack of discernible spatial trends, it has been determined that thallium concentrations in the creek and reservoir sediments from OU 3 are not significantly above background; therefore, thallium has been eliminated as a COC for all three IHSSs. This conclusion is supported by the Phase 1 Health Studies, which did not identify thallium as a material of concern (CDPHE, 1991b).

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### 5.6.3 Weight-of-Evidence Evaluations for Chemicals Without Toxicity Factors (Subsurface Sediments)

#### 5.6.3.1 Aluminum

Mean aluminum concentrations in IHSS 200 subsurface sediments (13,894 mg/kg) were less than the mean plus two standard deviations (15,714 mg/kg) given in the BGCR (DOE, 1993c) and slightly below the Lowry Landfill Superfund site background mean (13,959 mg/kg) (EPA, 1992). Maximum concentrations in IHSS 200 subsurface sediments (26,100 mg/kg) were slightly higher than the maximum concentration (25,200 mg/kg) given in the BGCR (DOE, 1993c), but less than the Lowry Landfill Superfund site background maximum concentration (32,100 mg/kg) (EPA, 1992). Maximum concentration of aluminum in IHSS 200 reservoir subsurface sediments (26,100 mg/kg) were also less than Cherry Creek Reservoir surface sediments (96,700 mg/kg), the only available benchmark data set with concentrations measured in a reservoir. No benchmark data sets with subsurface-sediment data for reservoirs were available for comparison.

Based on the similarity of the data sets, it has been determined that aluminum concentrations in IHSS 200 subsurface sediments are not significantly above background; therefore, aluminum has been eliminated as a COC. This conclusion is supported by the Phase 1 Health Studies, which did not identify aluminum as a material of concern (CDPHE, 1991b).

#### 5.6.3.2 Cesium

The mean concentration of cesium in IHSS 200 reservoir subsurface sediments was 16.7 mg/kg. This value was less than the mean given in the BGCR (DOE, 1993c) (69.3 mg/kg). The maximum detected cesium concentration in IHSS 200 (39.2 mg/kg) was less than the creek maximum (157 mg/kg) given in the BGCR (DOE, 1993c). No data for cesium were available from the Lowry Landfill Superfund site background data set (EPA, 1992). No benchmark reservoir subsurface sediment data were available for comparisons.

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Based on the similarity of the data sets, it has been determined that cesium concentrations in IHSS 200 subsurface sediments are not significantly above background; therefore, cesium has been eliminated as a COC. This conclusion is supported by the Phase 1 Health Studies, which did not identify cesium as a material of concern (CDPHE, 1991b).

#### 5.6.3.3 Cobalt

The mean concentration of cobalt in IHSS 200 reservoir subsurface sediments (9.4 mg/kg) was less than the mean plus two standard deviations (11.6 mg/kg) given in the BGCR (DOE, 1993c) and the Lowry Landfill Superfund site background mean (14.9 mg/kg) (EPA, 1992). The maximum concentration (12.2 mg/kg) was less than the maximum concentration (15 mg/kg) reported in the BGCR (DOE, 1993c) and the maximum concentration (14 mg/kg) reported in the Lowry Landfill Superfund site background data set (EPA, 1992). The mean concentration of cobalt in IHSS 200 reservoir subsurface sediment (9.47 mg/kg) was less than the mean concentration of cobalt (21.3 mg/kg) in Cherry Creek Reservoir, the only available reservoir benchmark literature data set.

Based on the similarity of the data sets, it has been determined that cobalt concentrations in IHSS 200 reservoir subsurface sediments are not significantly above background; therefore, cobalt has been eliminated as a COC. This conclusion is supported by the Phase 1 Health Studies, which did not identify cobalt as a material of concern (CDPHE, 1991b).

#### 5.6.3.4 Lead

The mean concentration of lead in IHSS 200 reservoir subsurface sediment (47.2 mg/kg) was less than the mean plus two standard deviations as given in the BGCR (DOE, 1993c) and the background data set from the Lowry Landfill Superfund site (95.6 mg/kg and 162 mg/kg, respectively) (EPA, 1992). The maximum concentration in IHSS 200 reservoir subsurface sediments (126.0 mg/kg) was less than the maximum concentrations given in the BGCR (DOE, 1993c) and the background data set from the Lowry Landfill Superfund site (244 mg/kg and 380 mg/kg, respectively) (EPA, 1992). The mean concentration of lead in IHSS 200 reservoir

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subsurface sediment (47.2 mg/kg), however, was greater than the mean (13.7 mg/kg) reported for Rocky Mountain National Park reservoir subsurface sediments.

Based on the similarity of the data sets, it has been determined that lead is not significantly above background and has been eliminated as a COC.

#### 5.6.3.5 Lithium

The mean lithium concentration in IHSS 200 reservoir subsurface sediment (11.7 mg/kg) was less than the mean plus two standard deviations (18 mg/kg) in the BGCR (DOE, 1993c). No data were available for lithium in the Lowry Landfill Superfund site background data set (EPA, 1992). The maximum detected reservoir subsurface sediment value in IHSS 200 (19.6 mg/kg) was less than the creek maximum (20.2 mg/kg) as given in the BGCR (DOE, 1993c). Reservoir benchmark literature data were unavailable for lithium.

Based on the similarity of the data sets, it has been determined that lithium concentrations in IHSS 200 subsurface sediments are not significantly above background; therefore, lithium has been eliminated as a COC. This conclusion is supported by the Phase 1 Health Studies, which did not identify lithium as a material of concern (CDPHE, 1991b).

### 5.7 CHEMICALS OF CONCERN

Based on the COC selection process,  $^{239/240}\text{Pu}$  is a COC in IHSS 200 for surface sediments. There are no COCs for subsurface sediments in IHSS 200 or surface sediments for IHSSs 201 and 202.

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## 6.0 CHEMICALS OF CONCERN IN SURFACE WATER

### 6.1 INTRODUCTION

The surface-water investigation consisted of the sampling and analysis of water from the creeks/drainages (Walnut Creek, Woman Creek, Dry Creek Valley Ditch, Church Ditch, Coal Creek, and Big Dry Creek) and reservoirs (Standley Lake, Great Western Reservoir, and Mower Reservoir) in OU 3. A total of 52 surface-water samples (excluding quality-control samples) were collected from 33 sample locations. The purpose of the surface-water sampling and subsequent chemical analysis was to characterize radionuclides and metals contained within the creeks/drainages and reservoirs in OU 3.

The steps that were followed in the COC selection process for surface water considered elimination of essential nutrients, elimination of chemicals infrequently detected, a concentration-toxicity screen, comparison to PRGs, and weight-of-evidence evaluations (as described in Subsection 3.7). Statistical comparison tests using the guidance developed by Gilbert (EG&G, 1994a) were not performed for surface water because of insufficient sample size and lack of a comparable background data set. The chemicals analyzed in surface water that were later eliminated during each step in the COC process for each IHSS are summarized in Table 6-1. Based on this COC selection process and the weight-of-evidence evaluation, there are no COCs for surface water. The elimination of water-quality parameters and essential nutrients was discussed in Subsections 2.7 and 3.2, respectively. The remainder of the COC selection steps are described in the following subsections.

### 6.2 DATA EVALUATION

The surface-water samples were analyzed for dissolved and total radionuclides, dissolved and total metals, atrazine, simazine, and water-quality parameters. VOCs were analyzed only at Mower Reservoir. In addition, several samples in IHSS 200 were also analyzed for various tripesticides (10 pesticides, including atrazine and simazine).

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TABLE 6-1

**COC SELECTION PROCESS RESULTS<sup>a</sup> FOR SURFACE WATER<sup>b</sup>**  
 (Chemicals are shown below the step by which they were eliminated as a COC)

Zero Detections	Statistical Comparison Tests	Essential Nutrients Screen	Detection Frequency Screen	Concentration-Toxicity Screen	PRG Screen	Weight-of-Evidence Evaluation	Chemicals Without Toxicity Factor <sup>c</sup>	COCs
<b>IHSS 200 - Great Western Reservoir</b>								
Antimony Cyanide Mercury Selenium Silver Thallium Atrazine Simazine Tripesticides <sup>d</sup>	NA	Calcium Magnesium Iron Sodium Potassium	None	Nickel Tin	Arsenic Beryllium Manganese Cadmium Molybdenum Barium Vanadium Chromium Zinc Copper Strontium Tritium <sup>238/240</sup> Pu <sup>233/234</sup> U <sup>235</sup> U <sup>238</sup> U <sup>241</sup> Am	None	Lead Lithium Aluminum Cobalt Silicon	None
<b>IHSS 201 - Standley Lake</b>								
Antimony Arsenic Beryllium Cadmium Cesium Silver Thallium Tin Vanadium Atrazine Simazine	NA	Calcium Magnesium Iron Sodium Potassium	None	Barium Zinc Chromium Copper Strontium	Manganese Mercury Nickel Molybdenum Cyanide Selenium <sup>233/234</sup> U <sup>235</sup> U <sup>238</sup> U <sup>241</sup> Am <sup>238/240</sup> Pu	None	Lead Lithium Silicon Cobalt Aluminum	None

<sup>a</sup>The COC selection process is discussed in Section 3.0.

<sup>b</sup>Total metals and total radionuclides (unfiltered).

<sup>c</sup>Chemicals without toxicity factors are evaluated using the weight-of-evidence evaluation.

<sup>d</sup>Tripesticides—Ametryn, atraton, prometon, prometryn, propazine, simetryn, terbutylazine, and terbutryn.

<sup>e</sup>VOAs = Volatile organic analyses; see Table 6-2 for complete list of analytes.

NA = Not applicable.

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TABLE 6-1

**COC SELECTION PROCESS RESULTS<sup>a</sup> FOR SURFACE WATER<sup>b</sup>**  
 (Chemicals are shown below the step by which they were eliminated as a COC)

Zero Detections	Statistical Comparison Tests	Essential Nutrients Screen	Detection Frequency Screen	Concentration-Toxicity Screen	PRG Screen	Weight-of-Evidence Evaluation	Chemicals Without Toxicity Factor <sup>c</sup>	COCs
<b>IHSS 202 - Mower Reservoir</b>								
Antimony	NA	Calcium	None	Strontium	Arsenic	None	Aluminum	None
Beryllium		Magnesium		Copper	Manganese		Cesium	
Cobalt		Iron		Zinc	Cadmium		Lead	
Selenium		Sodium		Tin	Molybdenum		Lithium	
Silver		Potassium			Barium		Silicon	
Thallium					Vanadium			
Cyanide					Chromium			
Atrazine					Mercury			
Simazine					Nickel			
VOAs <sup>d</sup>					<sup>239/240</sup> Pu			
					<sup>233/234</sup> U			
					<sup>235</sup> U			
					<sup>238</sup> U			
					<sup>241</sup> Am			

<sup>a</sup>The COC selection process is discussed in Section 3.0.

<sup>b</sup>Total metals and total radionuclides (unfiltered).

<sup>c</sup>Chemicals without toxicity factors are evaluated using the weight-of-evidence evaluation.

<sup>d</sup>Tripesticides—Ametryn, atraton, prometon, prometryn, propazine, simetryn, terbutylazine, and terbutryn.

<sup>e</sup>VOAs = Volatile organic analyses; see Table 6-2 for complete list of analytes.

NA = Not applicable.

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A summary of the data for OU 3 surface water for each IHSS is presented in Appendix C, which includes a summary for all the analyses performed for surface water. IHSS summary statistics (number of detects, number of samples, frequency of detection, minimum nondetect, maximum nondetect, minimum detect, maximum detect, arithmetic mean, geometric mean, standard deviation, normal upper 95 percent confidence limit, and lognormal upper 95 percent confidence limit) are presented in Tables C-9 through C-13.

The COC selection process for surface water focused on total metals and total radionuclides (rather than dissolved analytes) because the results of the total analyses (i.e., unfiltered samples) are representative of human exposure to unfiltered surface water. Generally, concentrations of total constituents are greater than the corresponding filtered (dissolved) constituents because they include both the suspended and dissolved fraction of the analyte measured. Therefore, this is a conservative approach. Water-quality parameters are not carried through the COC selection process for surface water. The filtered (dissolved) analyses and water-quality parameters will be discussed in the nature-and-extent discussion in the RFI/RI Report and are included in the summary statistics tables in Appendix C. The following subsections describe the results of the COC selection process.

### 6.3 DETECTION FREQUENCY

The COC selection process eliminates chemicals that are not detected in a given medium. Chemicals that were not detected in each surface-water IHSS are summarized in Table 6-1. In IHSS 200, 6 metals and 10 tripesticides (atrazine, simazine, ametryn, atraton, prometon, prometryn, propazine, simetryn, terbuthylazine, and terbutryn) were not detected and therefore were eliminated. In IHSS 201 and 202, six and seven metals, respectively, were not detected. Atrazine and simazine were also not detected in either IHSS. In IHSS 202, no VOAs were detected. The VOAs analyzed but not detected are summarized in Table 6-2. These chemicals have been eliminated from the COC list for surface water. No chemicals were detected at a frequency between zero and 5 percent, so the comparison to 1,000 times the PRG, as described in Subsection 3.4, was not performed.

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**TABLE 6-2**  
**SUMMARY OF VOLATILE ORGANIC ANALYTES ANALYZED BUT NOT DETECTED**  
**IN SURFACE WATER IN IHSS 202 (MOWER RESERVOIR)**

Analyte
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,2-DICHLOROETHANE
1,2-DICHLOROETHENE
1,2-DICHLOROPROPANE
2-BUTANONE
2-HEXANONE
4-METHYL-2-PENTANONE
ACETONE
BENZENE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CIS-1,3-DICHLOROPROPENE
DIBROMOCHLOROMETHANE
ETHYLBENZENE
METHYLENE CHLORIDE
STYRENE
TETRACHLOROETHENE
TOLUENE
TOTAL XYLENES
TRANS-1,3-DICHLOROPROPENE
TRICHLOROETHENE
VINYL ACETATE
VINYL CHLORIDE

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#### 6.4. CONCENTRATION-TOXICITY SCREEN

Chemicals contributing to 99 percent of the risk in the concentration-toxicity screen, as described in Subsection 3.5, are summarized by IHSS in Appendix D. Chemicals contributing to less than 1 percent of the risk are eliminated. As shown in Table 6-1, two chemicals were eliminated for IHSS 200, six chemicals for IHSS 201, and four chemicals for IHSS 202.

#### 6.5 PRG SCREEN

Based on the PRG screen presented in the Programmatic Preliminary Remediation Goals (DOE, 1994b) for surface water, 16 chemicals were eliminated from IHSS 200, 13 chemicals were eliminated from IHSS 201, and 14 chemicals were eliminated from IHSS 202 (see Table 6-1). The PRG calculations are presented in Appendix E. No chemicals detected in surface water exceed the PRG. Based on the COC selection process, the only remaining chemicals are those chemicals that do not have toxicity factors.

#### 6.6 WEIGHT-OF-EVIDENCE EVALUATIONS FOR CHEMICALS WITHOUT TOXICITY FACTORS

The chemicals that remain for each IHSS (see Table 6-1) that do not have EPA-derived toxicity factors are the following:

- Lead
- Aluminum
- Silicon
- Lithium
- Cobalt (IHSS 200, 201 only)
- Cesium (IHSS 200, 202 only)

As previously stated, the only chemicals remaining after the PRG screen are chemicals that do not have EPA-derived toxicity factors. These chemicals were evaluated using the weight-of-evidence (Table 6-1) evaluations described in Subsection 3.7 to determine if the chemical was

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consistently detected above background and therefore should be classified as a COC. The weight-of-evidence evaluation included the following:

- Comparison of OU 3 data to background data for surface water (BGCR, 1993c) and benchmark data (comparison of means and ranges)
- Temporal analysis of the OU 3 data
- Spatial analysis of OU 3 data
- Evaluation of measurement uncertainty
- Geochemical evaluations

Stream water for each IHSS was qualitatively compared to the data from the Background Geochemical Characterization Report (DOE, 1993c), which included 175 samples collected from February 1989 to December 1992. The OU 3 data set had an insufficient number of data points for a statistical comparison to background data and was subsequently compared qualitatively to these data.

No appropriate background data sets from the Background Geochemical Characterization Report (DOE, 1993c) were available for statistical comparisons to reservoir water to be able to apply the Gilbert statistical approach. Thus, the data for OU 3 reservoir water were compared qualitatively against the stream water data from the Background Geochemical Characterization Report (DOE, 1993c). Data for OU 3 reservoir water and data for background stream water were similar in geologic setting and location, thereby justifying a qualitative comparison. Additionally, data for both stream water and reservoir water were compared qualitatively to the benchmark values. Benchmark stream water included Ralston Creek, Croke Canal, and Farmer's Highline Canal (Arvada, 1994DB). These streams are near the site and some feed Standley Lake. Data for OU 3 reservoir water were compared to those of Chatfield Reservoir, Cherry Creek Reservoir, Bear Creek Lake, and Harriman Lake (Arvada, 1994; EPA, 1993 and 1994). Benchmark values were available for aluminum, antimony, arsenic, barium, cadmium,

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calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, strontium, and zinc.

The reservoir benchmark data were obtained from EPA's STORET database (EPA, 1993DB and 1994DB). The EPA database contains water-quality information from 1970 through 1993.

Summary statistics for the chemicals that have not been eliminated based on the PRG screen (chemicals that do not have toxicity factors) for each IHSS are presented in Table 6-3. Included in Table 6-3 is a summary of the benchmark data for the reservoirs. Where benchmark values were not found for the reservoirs, the data were compared to the background data for streams. The measurement uncertainty has been considered in determining if the OU 3 results significantly exceed background values. "Under optimum conditions, the analytical results for major analytes in surface water have an accuracy of  $\pm 2$  to  $\pm 10$  percent" (Hem, 1985). To address analytical uncertainty as well as sampling uncertainty, the OU 3 means have also been compared to the background mean plus two standard deviations.

The IHSS mean and maximum values for cesium, cobalt, lithium, and silicon are less than the values for background means and maximums as shown in Table 6-3. This is also the case for aluminum in IHSS 201 and 202. Benchmark data are available for aluminum, cobalt, and lithium. The benchmark data are similar to the OU 3 data for these chemicals. This indicates the OU 3 data for these chemicals are consistently below background values and therefore are not considered COCs.

For aluminum in IHSS 200 and lead in each of the IHSSs, additional evaluations have been performed and are discussed in the following paragraphs.

#### **6.6.1 IHSS 200 – Aluminum**

In IHSS 200, the mean stream concentration (1,042.9  $\mu\text{g/L}$ ) for total aluminum is greater than the background mean (758.89  $\mu\text{g/L}$ ). However, the mean for IHSS 200 is within two standard deviations (3,478  $\mu\text{g/L}$ ) of the background mean. The maximum aluminum value detected in IHSS 200 (4,260  $\mu\text{g/L}$ ) is less than the maximum detected in background streams (6,560  $\mu\text{g/L}$ ).

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TABLE 6-3

SUMMARY STATISTICS FOR SURFACE WATER\* BY IHSS FOR WEIGHT-OF-EVIDENCE EVALUATIONS

Chemical Name	Unit	IHSS Area	Number of Defects	Number of Samples	Frequency of Detection**	Minimum Nondetected Value	Maximum Nondetected Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean	Standard Deviation	Coefficient of Variation
ALUMINUM	µg/L	BKGNB	106	139	0.76	18.70	988.00	25.00	6560.00	758.89	1360.09	1.79
ALUMINUM	µg/L	BM-LAKE		126				2.00	2627.00	187 to 665		
ALUMINUM	µg/L	CREEK	8	8	1.00			344.00	1990.00	1042.88	668.61	0.64
ALUMINUM	µg/L	200	19	19	1.00			32.20	4260.00	1402.48	1035.07	0.74
ALUMINUM	µg/L	201	20	20	1.00			65.20	1540.00	404.47	356.02	0.88
ALUMINUM	µg/L	202	13	13	1.00			25.90	198.00	92.55	55.66	0.6
CESIUM	µg/L	BKGNB	10	120	0.08	2.00	2500.00	50.00	400.00	241.78	184.80	0.76
CESIUM	µg/L	CREEK	0	8	0.00	50.00	500.00			109.38	116.45	1.06
CESIUM	µg/L	200	5	19	0.26	50.00	500.00	50.00	90.00	69.21	82.15	1.19
CESIUM	µg/L	201		20		50.00	50.00			25.00		
CESIUM	µg/L	202	3	13	0.23	50.00	50.00	50.00	80.00	33.85	17.93	0.53
COBALT	µg/L	BKGNB	8	116	0.07	2.00	50.00	2.70	7.90	5.35	8.07	1.51
COBALT	µg/L	BM-LAKE		5					4.00	1.00		
COBALT	µg/L	CREEK	0	8	0.00	1.30	2.70			1.10	0.29	0.27
COBALT	µg/L	200	3	19	0.16	1.30	2.70	1.50	2.60	1.14	0.47	0.42
COBALT	µg/L	201	2	20	0.10	1.30	2.30	1.30	1.90	0.97	0.34	0.35
COBALT	µg/L	202		13		1.30	2.30			0.84	0.25	0.3

\*Reported results are total analyses.

\*\*Detection frequency is not available for benchmark data.

Area:

B = Background Geochemical Characterization Report data (stream) (DOE, 1993c).

S = OU 3 (OU 3 Database).

BM-LAKE = Benchmark values for lakes.

BKGNB = Background.

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TABLE 6-3

SUMMARY STATISTICS FOR SURFACE WATER\* BY IHSS FOR WEIGHT-OF-EVIDENCE EVALUATIONS

Chemical Name	Unit	IHSS	Area	Number of Detects	Number of Samples	Frequency of Detection**	Minimum Nondetected Value	Maximum Nondetected Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean	Standard Deviation	Coefficient of Variation
ALUMINUM	µg/L	BKGNL	B	106	139	0.76	18.70	988.00	25.00	6560.00	758.89	1360.09	1.79
ALUMINUM	µg/L	BM-LAKE	B		126				2.00	2627.00	187 to 665		
ALUMINUM	µg/L	CREEK	S	8	8	1.00			344.00	1990.00	1042.88	668.61	0.64
ALUMINUM	µg/L	200	S	19	19	1.00			32.20	4260.00	1402.48	1035.07	0.74
ALUMINUM	µg/L	201	S	20	20	1.00			65.20	1540.00	404.47	356.02	0.88
ALUMINUM	µg/L	202	S	13	13	1.00			25.90	196.00	92.55	55.66	0.6
CESIUM	µg/L	BKGNL	B	10	120	0.08	2.00	2500.00	50.00	400.00	241.78	184.80	0.76
CESIUM	µg/L	CREEK	S	0	8	0.00	50.00	500.00	50.00	90.00	109.38	116.45	1.06
CESIUM	µg/L	200	S	5	19	0.26	50.00	500.00	50.00	90.00	69.21	82.15	1.19
CESIUM	µg/L	201	S	20	20		50.00	50.00	50.00	80.00	25.00	17.93	0.53
CESIUM	µg/L	202	S	3	13	0.23	50.00	50.00	50.00	80.00	33.85	17.93	0.53
COBALT	µg/L	BKGNL	B	8	116	0.07	2.00	50.00	2.70	7.90	5.35	8.07	1.51
COBALT	µg/L	BM-LAKE	B		5					4.00	1.00		
COBALT	µg/L	CREEK	S	0	8	0.00	1.30	2.70	1.50	2.60	1.10	0.29	0.27
COBALT	µg/L	200	S	3	19	0.16	1.30	2.70	1.50	2.60	1.14	0.47	0.42
COBALT	µg/L	201	S	2	20	0.10	1.30	2.30	1.30	1.90	0.97	0.34	0.35
COBALT	µg/L	202	S		13		1.30	2.30			0.84	0.25	0.3

\*Reported results are total analyses.

\*\*Detection frequency is not available for benchmark data.

Area:

B = Background Geochemical Characterization Report data (stream) (DOE, 1993c).

S = OU 3 (OU 3 Database).

BM-LAKE = Benchmark values for lakes.

BKGNL = Background.

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Benchmark values for aluminum range from 2 to 2,627  $\mu\text{g/L}$  for reservoir waters; the maximum value was detected in Chatfield Reservoir. Figure 6-1 presents a summary of aluminum concentrations for all of the IHSSs.

Spatial analyses were performed for OU 3 analytes by reviewing patterns of concentrations at discrete sample points. No patterns or trends were identified to suggest the presence of contamination (see Appendix F).

Hem stated that "Aluminum is the third most abundant element in the earth's outer crust..." and "Aluminum occurs in substantial amounts in many silicate igneous rock minerals..." (Hem, 1985). Because the concentration of aluminum in surface water of IHSS 200 is not above maximum values in background (Figure 6-1), because no trends were identified indicating contamination, and because aluminum is abundant in the environment (Hem, 1985), aluminum is not considered a COC for surface water in OU 3. Further, aluminum is not one of the metals identified in the Phase 1 Health Studies Materials of Concern list as a potential contaminant from the RFETS.

#### **6.6.2 IHSSs 200, 201, and 202 – Lead**

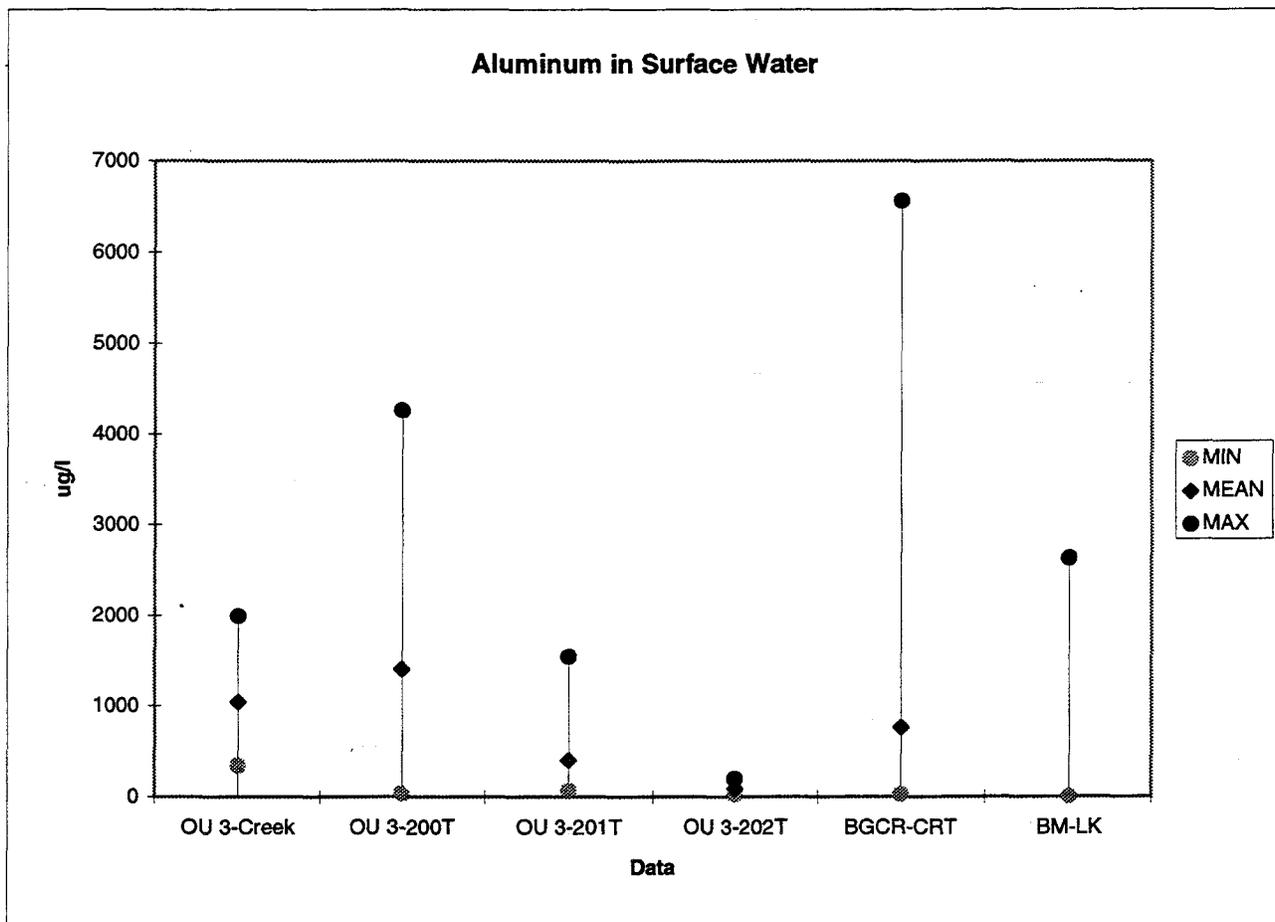
In IHSS 200, the mean concentration of lead was 7.04  $\mu\text{g/L}$  and maximum value detected was 18.5  $\mu\text{g/L}$ . In IHSS 201, the mean concentration of lead was 4.43  $\mu\text{g/L}$ , and the maximum value detected was 10.7  $\mu\text{g/L}$ . In IHSS 202, the mean was 7.22  $\mu\text{g/L}$  and the maximum value was 37.2  $\mu\text{g/L}$  (Table 6-2). The reservoir benchmark values for lead ranged from 1 to 888  $\mu\text{g/L}$ ; Cherry Creek and Chatfield reservoirs had the highest values for lead (888 and 644  $\mu\text{g/L}$ , respectively). The maximum values detected in Harriman Lake and Bear Creek Lake were 11  $\mu\text{g/L}$ , which is similar to the levels found in the OU 3 IHSSs. Figure 6-2 displays the similarity of the data sets.

An analysis was performed on a subset of the surface-water data set (arsenic, lead, manganese, silicon, and iron) for OU 3 using PROBLOT (see Appendix G). As described in Appendix G, data for OU 3 surface water and the background data for streams were combined and evaluated using PROBLOT. Using a cumulative frequency statistical analysis, the results

**ALUMINUM IN SURFACE WATER**

(µg/L)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3-Creek	344	1042.88	1990	668.61	Stream Surface Water (OU 3 Database)
OU 3-200T	32.2	1402.48	4260	1035.07	Great Western Reservoir (Lake) (Total Analysis) OU 3 Database
OU 3-201T	65.2	404.47	1540	356.02	Standley Lake (Lake) (Total Analysis) OU 3 Database
OU 3-202T	25.9	92.55	196	55.66	Mower Reservoir (Lake) (Total Analysis) OU 3 Database
BGCR-CRT	25	758.89	6560	1360.09	Background Geochemical Characterization Report (DOE, 1993c)
BM-LK	2		2627		Benchmark values, lakes/reservoirs, CO Front Range



Notes: If blank, no data are available.

OU 3-200 = IHSS 200 Creeks and Lake surface water data.

OU 3-201 = IHSS 201 Creeks and Lake surface water data.

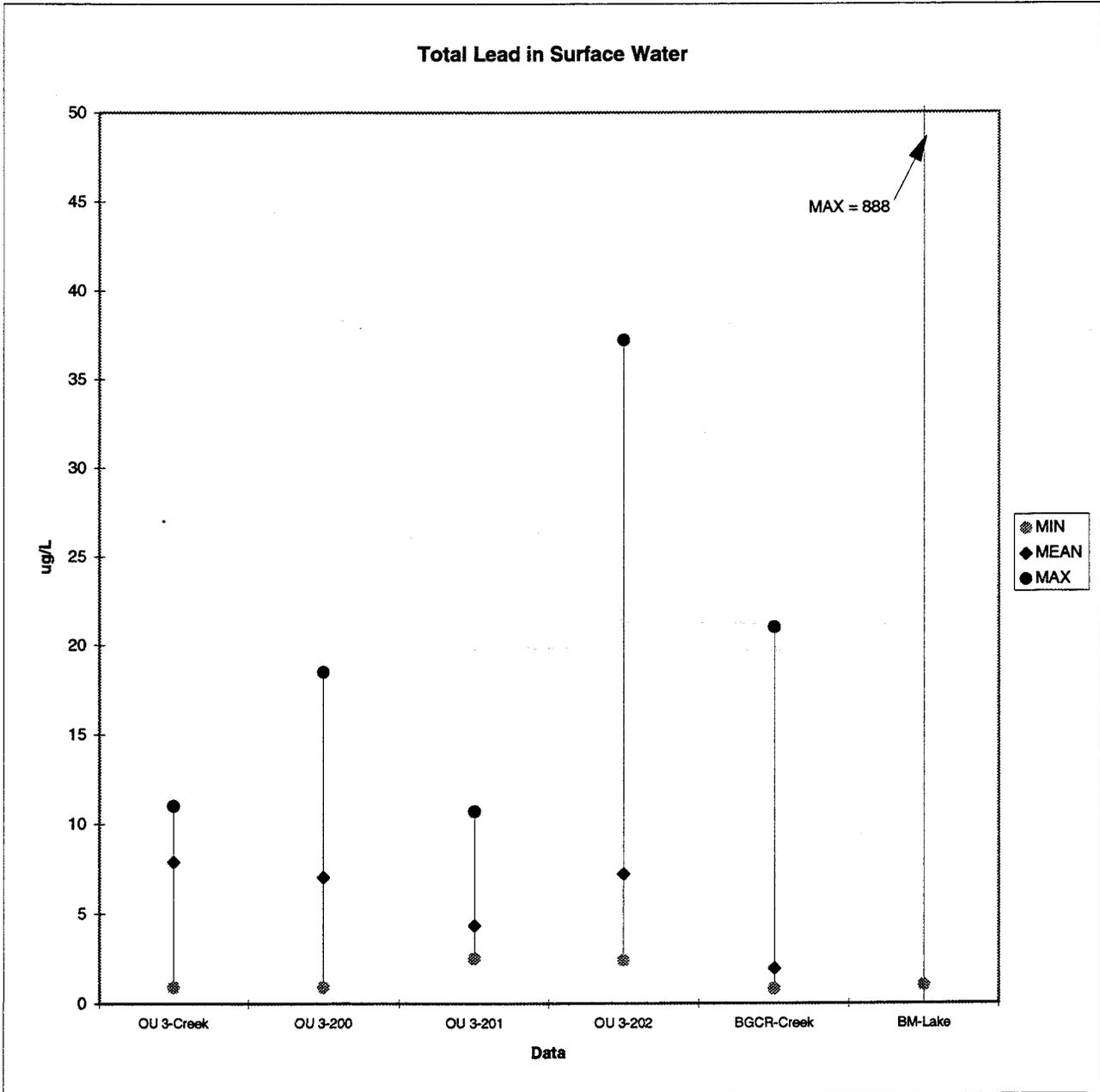
OU 3-202 = IHSS 202 Creeks and Lake surface water data.

**Figure 6-1  
ALUMINUM IN SURFACE WATER**

**TOTAL LEAD IN SURFACE WATER**

(µg/L)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3-Creek	0.9	7.89	11	3.81	IHSSs 200, 201, and 202 Stream Surface Water (OU 3 Database)
OU 3-200	0.9	7.04	18.5	0.424	Great Western Reservoir Surface Water (OU 3 Database)
OU 3-201	2.5	4.34	10.7		Standley Lake Surface Water (OU 3 Database)
OU 3-202	2.4	7.22	37.2	1.71	Mower Reservoir Surface Water (OU 3 Database)
BGCR-Creek	0.8	1.94	21	1.84	RFP Background Stream Surface Water, BGCR (DOE, 1993c)
BM-Lake	1		888		EPA STORET Data (EPA, 1993DB and 1994DB) Arvada Water Quality (Arvada, 1993DB)



Notes: If blank, no data are available.  
OU 3-200 = IHSS 200 in OU 3.

**Figure 6-2**  
**TOTAL LEAD IN SURFACE WATER**

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from PROBPLOT indicate only one population is present. This suggests there is no difference between the background data and the OU 3 data. Additionally, lead levels in OU 3 reservoir water are not above benchmark values. The results from statistical and PROBPLOT analysis indicate that lead is not a COC in OU 3 reservoir water.

## 6.7 CHEMICALS OF CONCERN

Based on the COC selection process and the weight-of-evidence evaluation, there are no COCs for surface water.

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## 7.0 CHEMICALS OF CONCERN IN GROUNDWATER

### 7.1 INTRODUCTION

Two groundwater wells were installed during the OU 3 field investigation: one downstream of Great Western Reservoir (IHSS 200, Well 49192) and one downstream of Standley Lake (IHSS 201, Well 49292). The wells were installed to evaluate the potential for contaminants to migrate from the surface-water bodies to shallow groundwater.

The COC selection steps that were followed for groundwater were elimination of essential nutrients, elimination of chemicals detected infrequently, concentration-toxicity screen, comparison to PRGs, and weight-of-evidence evaluations (as described in Subsection 3.7). Because of lack of sufficient groundwater data from OU 3 (as previously described in Subsection 3.1), statistical tests using the guidance developed by Gilbert (EG&G, 1994a) were not performed for groundwater. The chemicals that were eliminated during each step in the COC process for each IHSS are summarized in Table 7-1. Based on this COC selection process and the weight-of-evidence evaluation, there are no COCs for groundwater.

The elimination of water-quality parameters and essential nutrients were discussed in Subsections 2.7 and 3.2, respectively. The remainder of the COC selection steps are described in the subsections that follow.

### 7.2 DATA EVALUATION

Groundwater samples collected from the wells were analyzed for both dissolved and total metals, dissolved and total  $^{233/234}\text{U}$ ,  $^{235}\text{U}$ ,  $^{238}\text{U}$ , total  $^{239/240}\text{Pu}$ , total  $^{241}\text{Am}$ , and water-quality parameters. Each well was sampled nine times during 1993 (only eight rounds of data are currently entered into RFEDS). The COC selection process has focused on the total metal and total radionuclide analysis.

A summary of the data for OU 3 groundwater for each well is presented in Appendix C. The summary statistics by well location (number of detects, number of samples, frequency of

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TABLE 7-1  
COC SELECTION PROCESS<sup>a</sup> RESULTS FOR GROUNDWATER<sup>b</sup>  
(Chemicals are shown below the step by which they were eliminated as a COC)

Zero Detections	Statistical Comparison Tests	Essential Nutrients Screen	Detection Frequency Screen	Concentration-Toxicity Screen	PRG Screen	Weight-of-Evidence Evaluation	Chemicals without a Toxicity Factor <sup>c</sup>	COCs
IHSS 200 (Well 49192)	NA	Calcium Magnesium Iron Sodium Potassium	None	Copper Selenium Tin Zinc	<sup>241</sup> Am Barium Cadmium Chromium Nickel <sup>239/240</sup> Pu Strontium <sup>235</sup> U Vanadium	Arsenic Beryllium Manganese Antimony <sup>233/234</sup> U <sup>238</sup> U	Lead Lithium Cesium Aluminum Cobalt Silicon	None
IHSS 201 (Well 49292)	NA	Calcium Magnesium Iron Sodium Potassium	None	Copper Zinc <sup>239/240</sup> Pu	<sup>241</sup> Am Barium Chromium Manganese Molybdenum Strontium <sup>233/234</sup> U <sup>235</sup> U <sup>238</sup> U	Arsenic	Lead Lithium Silicon Aluminum	None

<sup>a</sup>COC selection process is discussed in Section 3.0.

<sup>b</sup>Total metals and total radionuclides (unfiltered).

<sup>c</sup>Chemicals without toxicity factors were subject to the weight-of-evidence evaluation.

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detection, minimum nondetect, maximum nondetect, minimum detect, maximum detect, arithmetic mean, geometric mean, standard deviation, normal upper 95 percent confidence limit, and lognormal upper 95 percent confidence limit) are presented in Tables C-14 and C-15. Appendix C includes a summary for all the analyses performed.

The COC selection process for groundwater focused on total metals and total radionuclides because the results of the total analyses (i.e., unfiltered samples) are representative of human exposure to unfiltered groundwater used as a drinking water source. Generally, results of total concentrations are greater than the corresponding filtered (dissolved) concentrations because they include both the suspended and dissolved fraction of the analyte measured. Therefore, this is a conservative approach. Water-quality parameters are not carried through the COC selection process for groundwater. The filtered (dissolved) analyses and water-quality parameters will be discussed in the nature-and-extent discussion in the RFI/RI report. The following paragraphs describe the results of the COC selection process.

### 7.3 DETECTION FREQUENCY

The COC selection process eliminates chemicals that are not detected in a given medium. Compounds that were not detected (zero percent detection frequency) in the groundwater wells are summarized in Table 7-1. Four chemicals were not detected in well 49192 (IHSS 200) and 12 chemicals were not detected in Well 49292 (IHSS 201). These chemicals have been eliminated from the COC list. No chemicals were detected between zero and 5 percent, so the comparison to 1,000 times the PRG as described in Subsection 3.4 was not performed.

### 7.4 CONCENTRATION-TOXICITY SCREEN

Chemicals contributing to 99 percent of the risk in the concentration-toxicity screen, as described in Subsection 3.5, are summarized by IHSS in Appendix D. Chemicals contributing to less than 1 percent of the risk are eliminated. Four chemicals were eliminated for IHSS 200 and three chemicals were eliminated for IHSS 201 based on this criteria, as shown in Table 7-1.

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## 7.5 PRG SCREEN

Based on the PRG screen for groundwater, 9 chemicals were eliminated from the COC list for IHSS 200, and 10 chemicals were eliminated for IHSS 201 (see Table 7-1). The PRG concentrations are presented in Appendix E.

## 7.6 WEIGHT-OF-EVIDENCE EVALUATIONS FOR CHEMICALS EXCEEDING PRGs

The chemicals that have not been eliminated based on the PRG screen are the following (i.e., these chemicals exceed the PRG):

### Well 49192 (IHSS 200)

- Arsenic (Maximum – 6.9  $\mu\text{g/L}$ , PRG = 0.04867  $\mu\text{g/L}$ )
- Antimony (Maximum – 27.5  $\mu\text{g/L}$ , PRG = 14.6  $\mu\text{g/L}$ )
- Beryllium (Maximum – 1.6  $\mu\text{g/L}$ , PRG = 0.0198  $\mu\text{g/L}$ )
- Manganese (Maximum – 959  $\mu\text{g/L}$ , PRG = 182.5  $\mu\text{g/L}$ )
- $^{233/234}\text{U}$  (Maximum – 4.6 pCi/L, PRG = 2.976 pCi/L)
- $^{238}\text{U}$  (Maximum – 4.2 pCi/L, PRG = 2.976 pCi/L)

### Well 49292 (IHSS 201)

- Arsenic (Maximum – 3.8  $\mu\text{g/L}$ , PRG = 0.04867  $\mu\text{g/L}$ )

Several other chemicals have not been eliminated from the COC list at this point because no toxicity factors are available. These chemicals are the following:

### Well 49192 (IHSS 200)

- Lead
- Lithium
- Aluminum

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- Cesium
- Cobalt
- Silicon

#### Well 49292 (IHSS 201)

- Lead
- Lithium
- Silicon
- Aluminum

The analytes remaining after the PRG screen (including chemicals without toxicity factors) were assessed by using the weight-of-evidence evaluation (Table 7-1) described in Subsection 3.7 to determine if the analyte was consistently detected above background and therefore should be considered a COC. The approach for evaluating these chemicals in groundwater included the following:

- Comparison of OU 3 data to background groundwater data for both upper and lower hydrostratigraphic units (UHSU and LHSU, respectively) at the RFETS and benchmark data (comparison of means and ranges)
- Temporal analysis of anomalies in the OU 3 data
- Evaluation of measurement uncertainty
- Geochemical evaluations of hydrologic setting

The OU 3 data that exceed the PRG (or that have no toxicity factors) were compared to the background data presented in the Background Geochemical Characterization Report (DOE, 1993c). Analytes for which the OU 3 mean and range were less than the comparative background groundwater data were eliminated as COCs.

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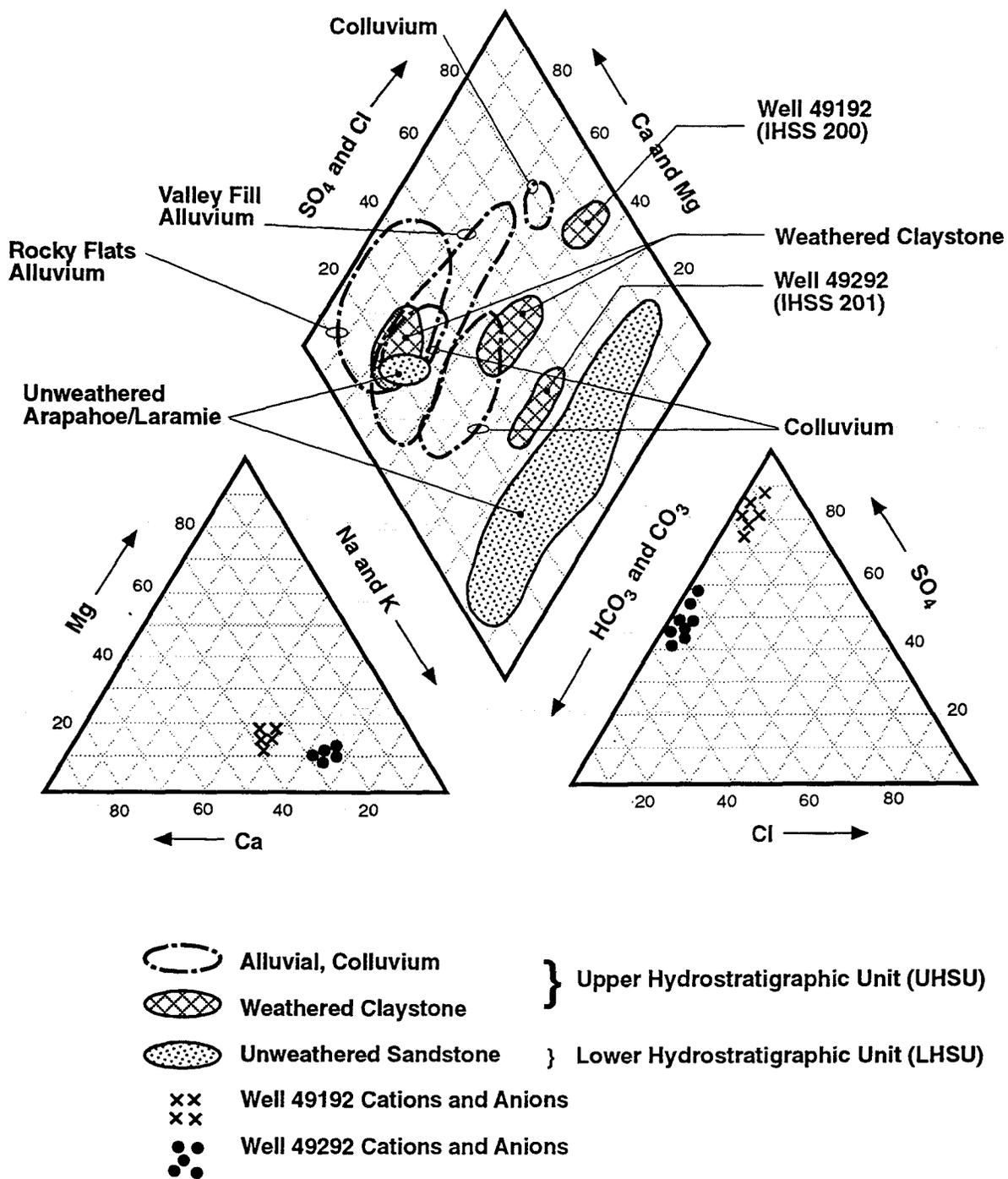
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To evaluate whether OU 3 groundwater data exceed background data, the OU 3 data were compared to the groundwater data sets presented in the Background Geochemical Characterization Report (DOE, 1993c). The background groundwater monitoring wells were selected to be representative of the upper hydrostratigraphic unit (UHSU) (Rocky Flats alluvium, the colluvium, valley fill alluvium, weathered claystone); and the lower hydrostratigraphic unit (LHSU) (the unweathered Arapahoe and Laramie formation bedrock).

A Piper diagram showing major-ion chemistry for the OU 3 groundwater wells and background UHSU and LHSU is presented in Figure 7-1. The concentrations of major anions (as meq/L [milliequivalents per liter]) are given as percentages of the total milliequivalents per liter. The water type for Well 49192 (IHSS 200) is sodium-sulfate enriched whereas the groundwater from Well 49292 (IHSS 201) is sodium-enriched with no dominant anion. The wells screened in the UHSU have a calcium-bicarbonate chemistry. Groundwater in the LHSU generally exhibits a sodium-sulfate to sodium-bicarbonate chemistry. Well 49192 (IHSS 200) has a water chemistry similar to the UHSU, whereas Well 49292 (IHSS 201) has a water chemistry more similar to the LHSU.

A number of reasons exist for spatial changes and differences in groundwater chemistry. Some changes may be due to the natural evolution of groundwater chemistry along a flow path, such as an increase in TDS content in the downgradient direction. Other changes in water chemistry may be the result of ion-exchange processes, oxidation/reduction reactions, or mineral precipitation/dissolution processes. However, the similarity of the water typing for the OU 3 wells compared to the background data groupings provides a suitable data set for determining if the OU 3 data are consistently above background, in conjunction with the temporal, analytical uncertainty, and geochemical evaluations.

Summary statistics of the OU 3 data (by well) that exceed the PRG screen or do not have toxicity factors are presented in Table 7-2. Also included in Table 7-2 are the minimum, maximum, arithmetic mean, standard deviation, and mean plus two standard deviations for the background data. Data for Well 49192 (IHSS 200) have been compared to the background data for the UHSU, and data for Well 49292 (IHSS 201) have been compared to the



**Figure 7-1**  
**PIPER DIAGRAM SHOWING MAJOR ION CHEMISTRY**  
**FOR OU 3 WELLS AND BACKGROUND GEOCHEMICAL**  
**GROUNDWATER WELLS**

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background data for the LHSU. Benchmark values presented by Dragun (1988) for those chemicals with available data have also been included in Table 7-2.

The measurement uncertainty has been considered in determining if the OU 3 groundwater results significantly exceed background. "Under optimum conditions, the analytical results for major analytes in groundwater have an accuracy of  $\pm 2$  to  $\pm 10$  percent. That is, the difference between the reported result and the actual concentration in the sample at the time of analysis should be between 2 and 10 percent of the actual value" (Hem, 1985). Analytes present in concentrations above 100 mg/L generally can be determined with an accuracy of better than  $\pm 5$  percent. The limits of precision (reproducibility) are similar. For analytes present in concentrations below 1 mg/L, the accuracy is generally not better than  $\pm 10$  percent and can be poorer (Hem, 1985). Except for the major anions and cations, most of the analytes for OU 3 are present in concentrations less than 1 mg/L. Therefore, the analytical accuracy can be estimated to be  $\pm 10$  percent. To address analytical uncertainty as well as sampling uncertainty, the OU 3 mean has also been compared to the value of the background mean plus two standard deviations.

#### 7.6.1 Chemicals Exceeding the PRG

Four chemicals for Well 49192 (IHSS 200) and two chemicals for Well 49292 (IHSS 201) that exceed a PRG have mean and maximum values that are less than the mean and maximum for the comparative background data, as shown in Table 7-2. This indicates the OU 3 analytes that have concentrations less than background and that are eliminated from the COC list. The following chemicals have been eliminated because the OU 3 mean and maximum concentrations/activity are less than those of the background data (UHSU and LHSU):

#### Great Western Reservoir Well 49192

- Antimony
- Beryllium
- $^{233/234}\text{U}$
- $^{238}\text{U}$

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### Standley Lake Well 49292

- Aluminum
- Arsenic

Chemicals present at concentrations that are similar to but not below the background mean and maximum include arsenic and manganese for Well 49192 (IHSS 200). These two chemicals have been evaluated using temporal variability, analytical uncertainty, and geochemical analyses to determine if these chemicals should be retained on the COC list for groundwater.

### Well 49192 (IHSS 200) – Arsenic

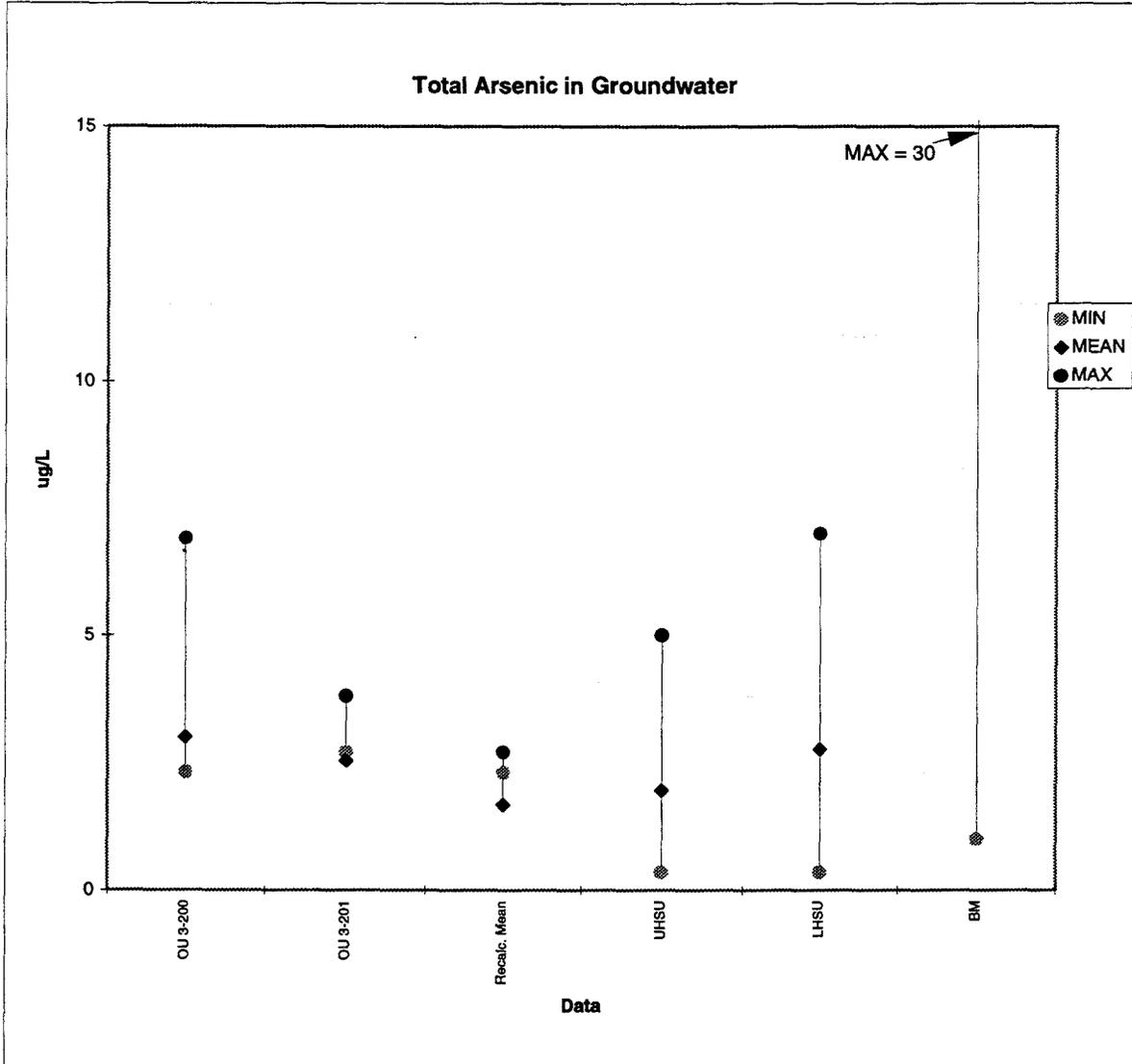
In Well 49192, the mean (2.99  $\mu\text{g/L}$ ) for total arsenic is greater than that for the background UHSU (1.95  $\mu\text{g/L}$ ). However, the mean (2.99  $\mu\text{g/L}$ ) is within two standard deviations of the background mean (5.37  $\mu\text{g/L}$ ), and is similar to the background mean (2.76  $\mu\text{g/L}$ ) for the LHSU (Table 7-2). The maximum total arsenic value detected in Well 49192 (6.9  $\mu\text{g/L}$ ) is similar to the maximum detected in the UHSU background data (5  $\mu\text{g/L}$ ) and less than the maximum detected in the LHSU background data (7  $\mu\text{g/L}$ ). Arsenic values found in literature for groundwater range from 1 to 30  $\mu\text{g/L}$  (Dragun, 1988). Figure 7-2 presents a graph displaying the similarity of the OU 3 data to background and benchmark data.

In reviewing the data from Well 49192, one anomaly was noted: three of the eight sample rounds had elevated amounts of total suspended solids (TSS). On January 29, 1993, April 29, 1993, and November 18, 1993, TSS were 840, 1300, and 948 mg/L, respectively. On the five other sample dates, the TSS were all less than 160 mg/L. The elevated amount of TSS, in conjunction with elevated total aluminum and total iron (over one order of magnitude greater than the other five sampling rounds), indicates that the sampling technique on those days may be suspect (see Figure 7-3). The correlation coefficients between TSS and aluminum and TSS and iron are 0.99 and 0.96, respectively. A review of the background TSS data for both the UHSU and the LHSU shows a small percentage (less than 10 percent) of TSS values greater than 500 mg/L. It is possible that when the sampling bailer was lowered in the well, the bailer

**TOTAL ARSENIC IN GROUNDWATER**

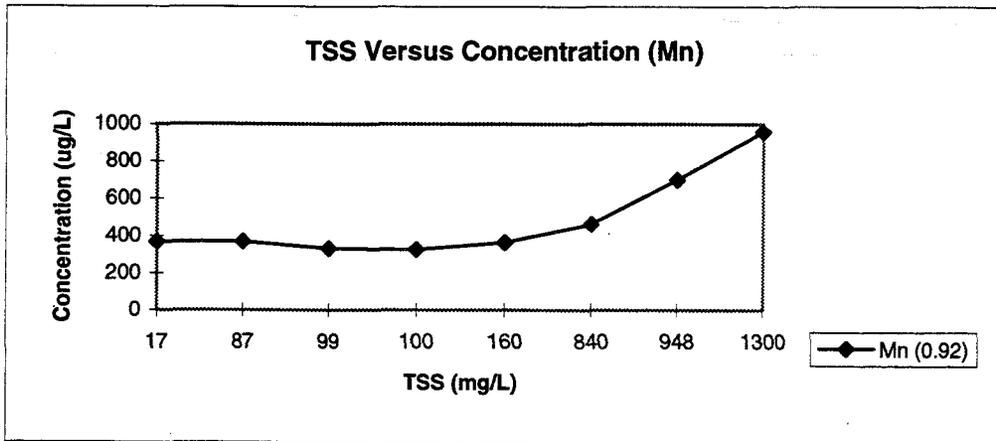
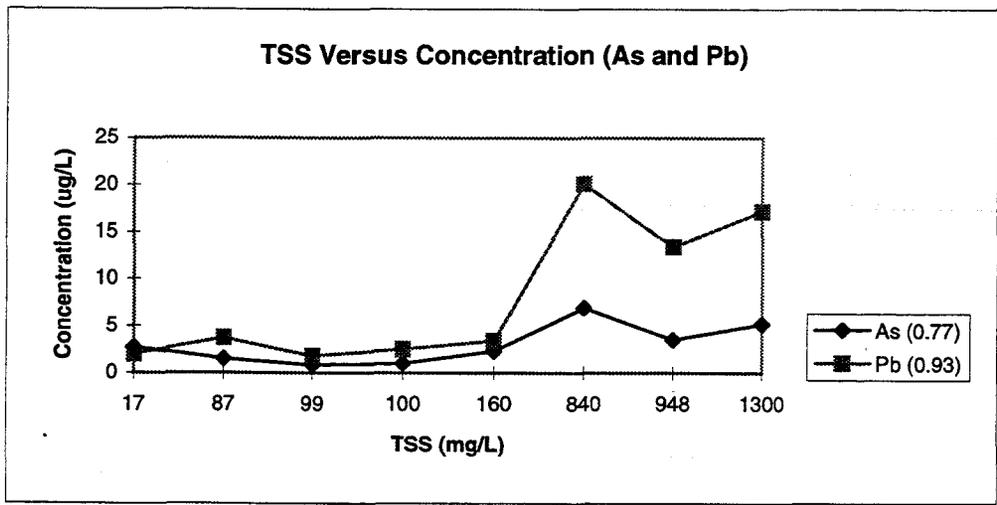
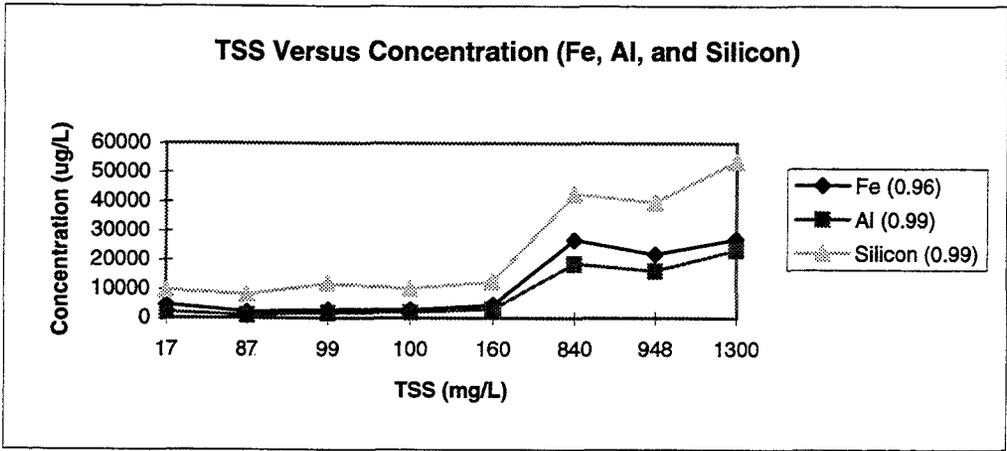
(µg/L)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3-200	2.3	2.99	6.9	0.711	OU 3 Well 49192 (8 sampling events) (OU 3 Database)
OU 3-201	2.7	2.53	3.8	0.424	OU 3 Well 49292 (8 sampling events) (OU 3 Database)
Recalc. Mean	2.3	1.67	2.7		OU 3 Well 49192 recalculated without sampling events associated with high TSS
UHSU	0.35	1.95	5	1.71	Weathered Claystone, BGCR (DOE, 1993c)
LHSU	0.35	2.76	7	2.02	Unweathered Arapahoe and Laramie Formation, BGCR (DOE, 1993c)
BM	1		30		Benchmark Data (Dragun, 1988)



Notes: If blank, no data are available.  
 OU 3-200 = IHSS 200 in OU 3.

**Figure 7-2**  
**TOTAL ARSENIC IN GROUNDWATER**



Note: Values in ( ) are correlation coefficients

**Figure 7-3**  
**TSS VERSUS CONCENTRATION FOR WELL 49192**

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may have hit the bottom of the well and dislodged sediments into the water column. Other total metal analyses are also higher during these three sample events.

The three greatest detections (6.9  $\mu\text{g/L}$ , 5.2  $\mu\text{g/L}$ , and 3.5  $\mu\text{g/L}$ ) of arsenic correlate with the three sampling events exhibiting elevated TSS (Figure 7-3). When the arithmetic mean for the well OU 3 data is recalculated, excluding the data from these three sampling events, the OU 3 mean (1.67  $\mu\text{g/L}$ , recalculated) is less than the UHSU background mean (as seen in Figure 7-2).

Based on the similarity of the OU 3 and the UHSU background means (less than two standard deviations of the background mean), the OU 3 mean being less than the LHSU background mean, the analytical and sampling uncertainty, and the potential for sampling error (three rounds with high values of TSS), arsenic concentrations in OU 3 groundwater were determined to be not above background; therefore, arsenic has been eliminated as a COC in OU 3 groundwater. This conclusion is supported by the Phase I Health Studies, which did not identify arsenic as a material of concern (CDPHE, 1991b).

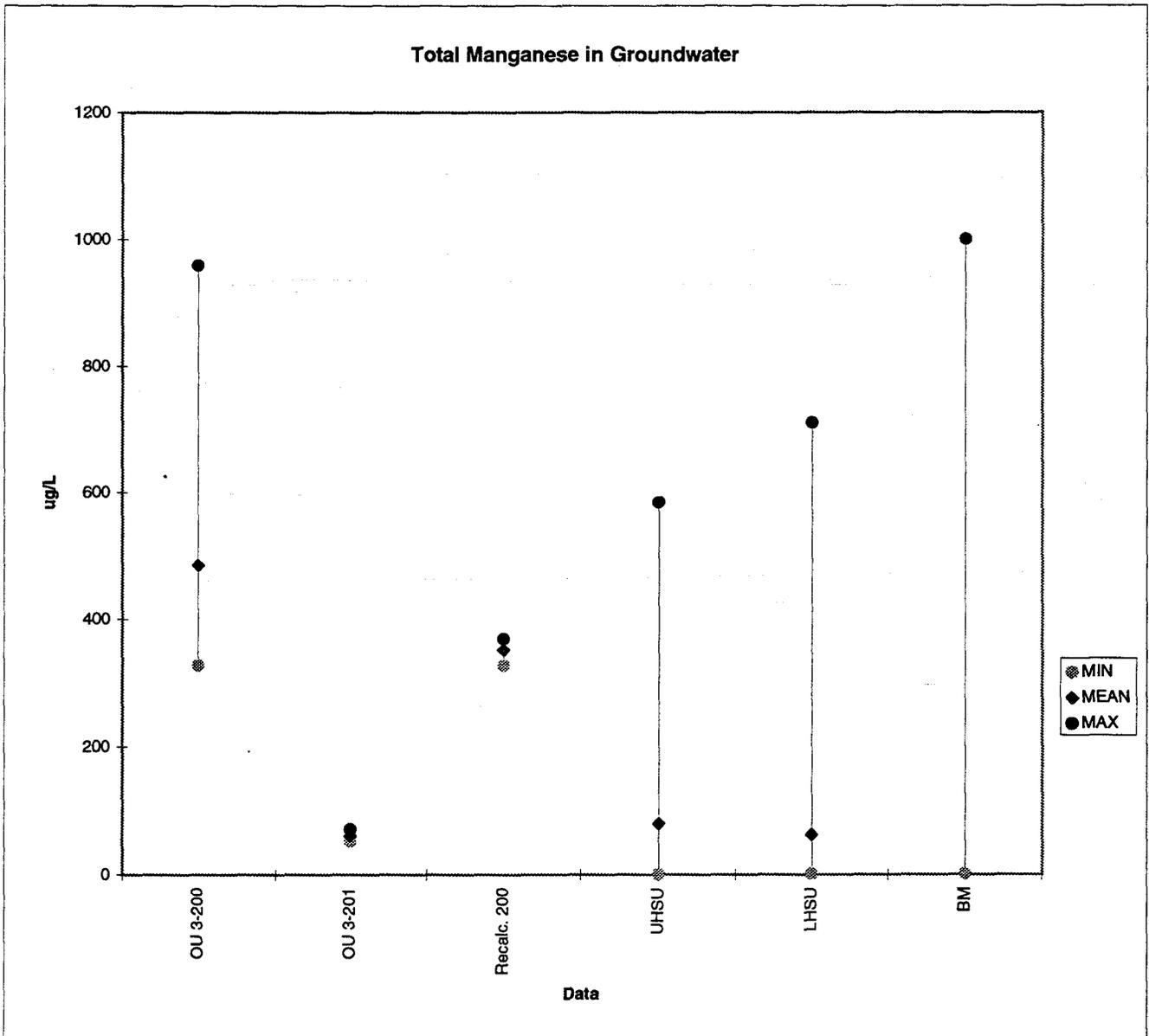
#### Well 49192 (IHSS 200) – Manganese

Both the mean and maximum values for total manganese in Well 49192 are greater than those of the UHSU background data. However, the maximum value (959  $\mu\text{g/L}$ ) detected in the well is less than the maximum value (1,000  $\mu\text{g/L}$ ) found in literature (Dragun, 1988). Figure 7-4 presents a graph showing the similarity of the OU 3 data to the background and benchmark data. The three highest detections of manganese (959, 700, and 463  $\mu\text{g/L}$ ) correlate with the three sampling rounds with the elevated TSS, indicating potential sampling error (Figure 7-3). The maximum value for OU 3 groundwater, excluding the detections with elevated TSS, is less than the maximum detected in the UHSU background data set. This, combined with the potential sampling error and the OU 3 data for IHSS 200 being less than the maximum benchmark values for manganese, has led to the elimination of manganese as a COC. This conclusion is supported by the fact that manganese is not one of the metals identified on the Phase 1 Health Studies Materials of Concern List as a likely contaminant from the RFETS (CDPHE, 1991b).

**TOTAL MANGANESE IN GROUNDWATER**

(µg/L)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3-200	327	485.2	959	227.26	OU 3 Well 49192 (8 sampling events) (OU 3 Database)
OU 3-201	52.8	60.11	70.2	5.717	OU 3 Well 49292 (8 sampling events) (OU 3 Database)
Recalc. 200	327	352	369		OU 3 Well 49192 recalculated without sampling events associated with high TSS
UHSU	0.5	79.59	584	108.18	Weathered Claystone, BGCR (DOE, 1993c)
LHSU	1	61.87	710	125.21	Unweathered Arapahoe and Laramie Formation, BGCR (DOE, 1993c)
BM	1		1000		Benchmark Data (Dragun, 1988)



Notes: If blank, no data are available.  
 OU 3-200 = IHSS 200 in OU 3.  
 UHSU = Upper hydrostratigraphic unit.  
 LHSU = Lower hydrostratigraphic unit.  
 BM = Benchmark.

**Figure 7-4**  
**TOTAL MANGANESE IN GROUNDWATER**

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## 7.6.2 Chemicals Without Toxicity Values

Cesium and cobalt for Well 49192 (IHSS 200) and aluminum and arsenic for Well 49292 (IHSS 201) have mean and maximum values that are less than the mean and maximum for the comparative background data, as shown in Table 7-2. This indicates the OU 3 data are less than background; therefore, cesium and cobalt are not considered COCs.

### Well 49192 (IHSS 200) – Aluminum

In Well 49192, the mean (8,499  $\mu\text{g/L}$ ) and the maximum (23,400  $\mu\text{g/L}$ ) exceed the UHSU background mean (2,743  $\mu\text{g/L}$ ) and maximum (19,950  $\mu\text{g/L}$ ). However, as described earlier, total aluminum was detected at two orders of magnitude greater during the three rounds of sampling with elevated TSS (Figure 7-3). When the mean is recalculated excluding the three data points associated with elevated TSS, the mean is 1,959  $\mu\text{g/L}$ , which is less than the UHSU background mean. The "uncorrected" mean for OU 3 data is less than the value of the background mean plus two standard deviations. Incidentally, dissolved aluminum was detected in only one groundwater sample from Well 49192, indicating the aluminum is associated with the solid particulates rather than the dissolved phase.

A comparison between the OU 3 data and the background data is presented in Figure 7-5 and shows the similarity between the data sets. The recalculated mean for Well 49192 has also been shown. Aluminum is the third most abundant element in the earth's crust and is a common constituent of rock-forming minerals (Hem, 1985). Based on this weight-of-evidence, aluminum concentrations in OU 3 groundwater are not above background; therefore, aluminum has been eliminated as a COC. This conclusion is supported by the Phase I Health Studies, which did not identify aluminum as a material of concern (CDPHE, 1991b).

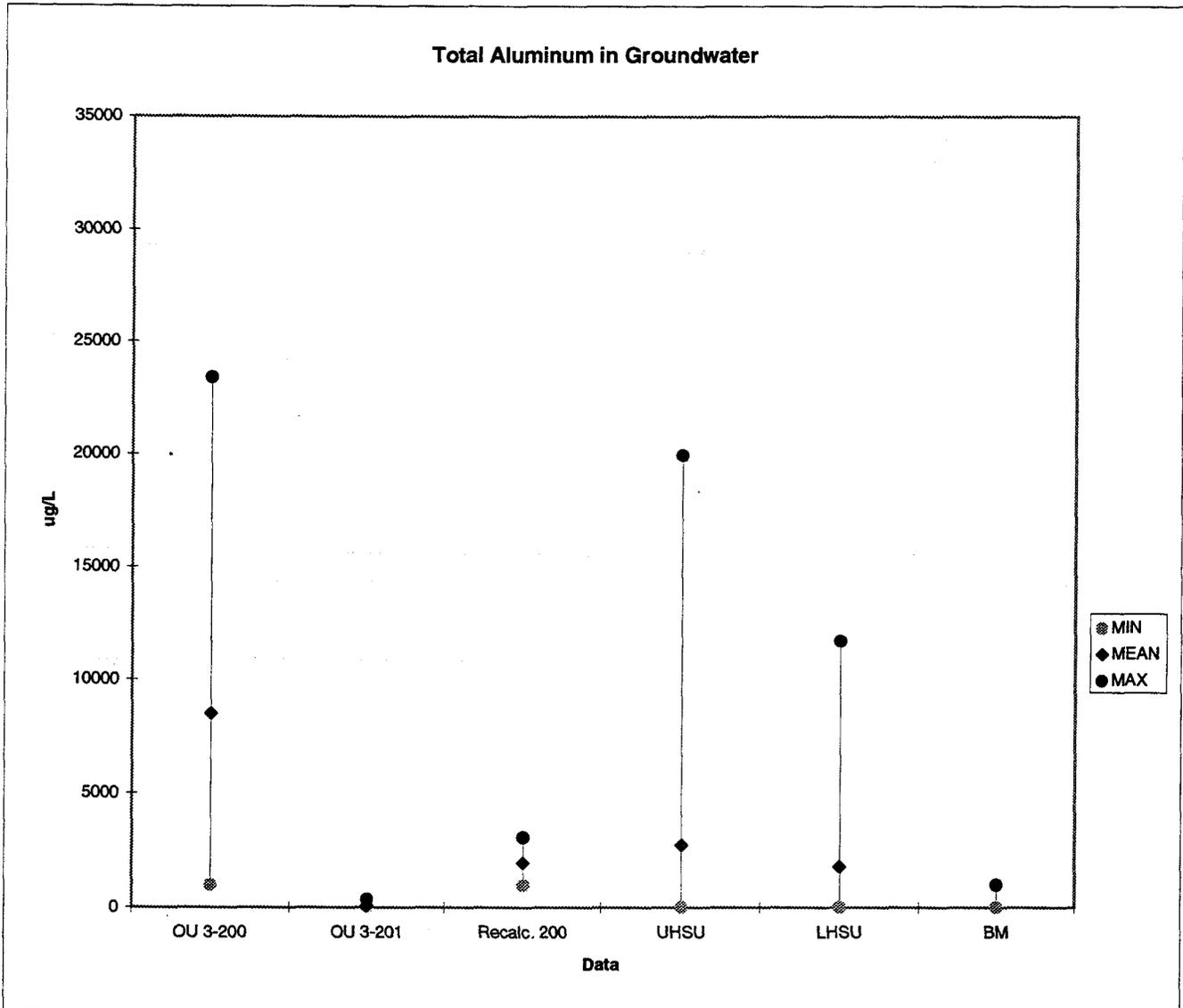
### Well 49192 (IHSS 200) – Lead

In Well 49192, the mean (7.89  $\mu\text{g/L}$ ) for total lead is greater than the background mean for the UHSU (3.26  $\mu\text{g/L}$ ), but less than the value of the background mean plus two standard deviations (10.54  $\mu\text{g/L}$ ). The well maximum (20.1  $\mu\text{g/L}$ ) is also less than the UHSU background

**TOTAL ALUMINUM IN GROUNDWATER**

(µg/L)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3-200	965	8499	23400	9254	OU 3 Well 49192 (8 sampling events) (OU 3 Database)
OU 3-201	28.2	72.01	338	108.7	OU 3 Well 49292 (8 sampling events) (OU 3 Database)
Recalc. 200	965	1959	3070		OU 3 Well 49192 recalculated without sampling events associated with high TSS
UHSU	22.6	2743	19950	4249	Weathered Claystone, BGCR (DOE, 1993c)
LHSU	11	1791	11700	2773	Unweathered Arapahoe and Laramie Formation, BGCR (DOE, 1993c)
BM	5		1000		Benchmark Data (Dragun, 1988)



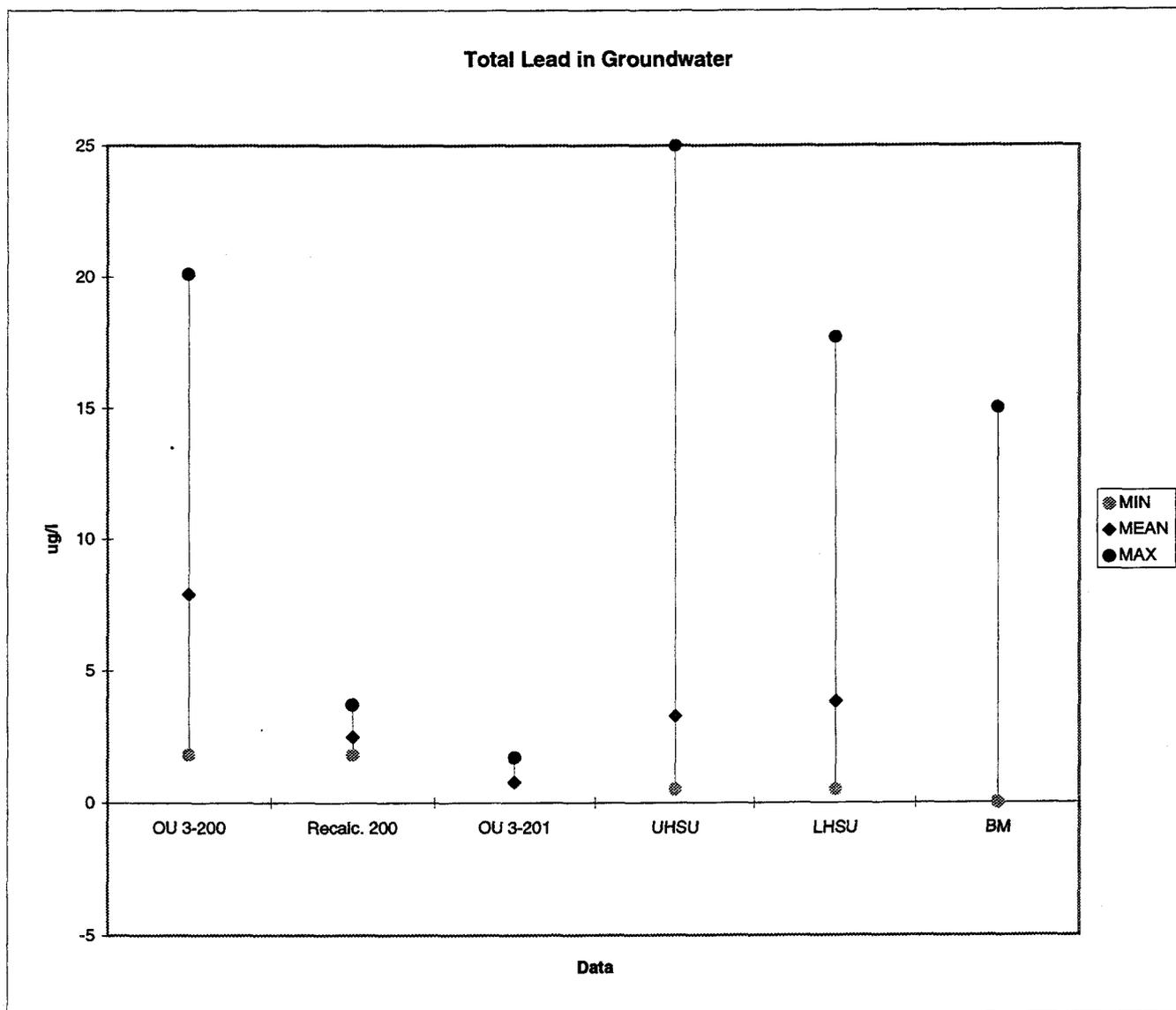
Notes: If blank, no data are available.  
 OU 3-200 = IHSS 200 in OU 3.  
 UHSU = Upper hydrostratigraphic unit.  
 LHSU = Lower hydrostratigraphic unit.  
 BM = Benchmark.

**Figure 7-5**  
**TOTAL ALUMINUM IN GROUNDWATER**

**TOTAL LEAD IN GROUNDWATER**

(µg/L)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3-200	1.8	7.89	20.1	7.72	OU 3 Well 49192 (8 sampling events) (OU 3 Database)
Recalc. 200	1.8	2.48	3.7		OU 3 Well 49292 (8 sampling events) (OU 3 Database)
OU 3-201	1.7	0.775	1.7	0.44	OU 3 Well 49192 recalculated without sampling events associated with high TSS
UHSU	0.5	3.26	25	3.64	Weathered Claystone, BGCR (DOE, 1993c)
LHSU	0.5	3.82	17.7	4.29	Unweathered Arapahoe and Laramie Formation, BGCR (DOE, 1993c)
BM	0		15		Benchmark Data (Dragun, 1988)



Notes: If blank, no data are available.  
 OU 3-200 = IHSS 200 in OU 3.  
 UHSU = Upper hydrostratigraphic unit.  
 LHSU = Lower hydrostratigraphic unit.  
 BM = Benchmark.

**Figure 7-6  
 TOTAL LEAD IN GROUNDWATER**

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maximum (25  $\mu\text{g/L}$ ). The three highest concentrations of lead measured in OU 3 groundwater (13.4, 17.2, and 20.1  $\mu\text{g/L}$ ) were associated with the three sampling events when the TSS were elevated (Figure 7-3). When the mean is recalculated without those values, the OU 3 mean (2.48  $\mu\text{g/L}$ ) is less than the background mean. Benchmark values for lead typically are as much as 15  $\mu\text{g/L}$  (Dragun, 1988). Figure 7-6 presents a comparison between the OU 3 data and the background data and shows the similarity between data sets.

In addition, dissolved concentrations of lead for Well 49192 are less than the corresponding background means and maximums (see Appendix C). If lead levels in OU 3 were significantly elevated over background, concentrations of both the dissolved and total fractions should be greater than those of the background data set. Based on the similarity of the OU 3 and background data, lead has been eliminated as a COC in OU 3 groundwater.

#### Well 49192 (IHSS 200) – Lithium

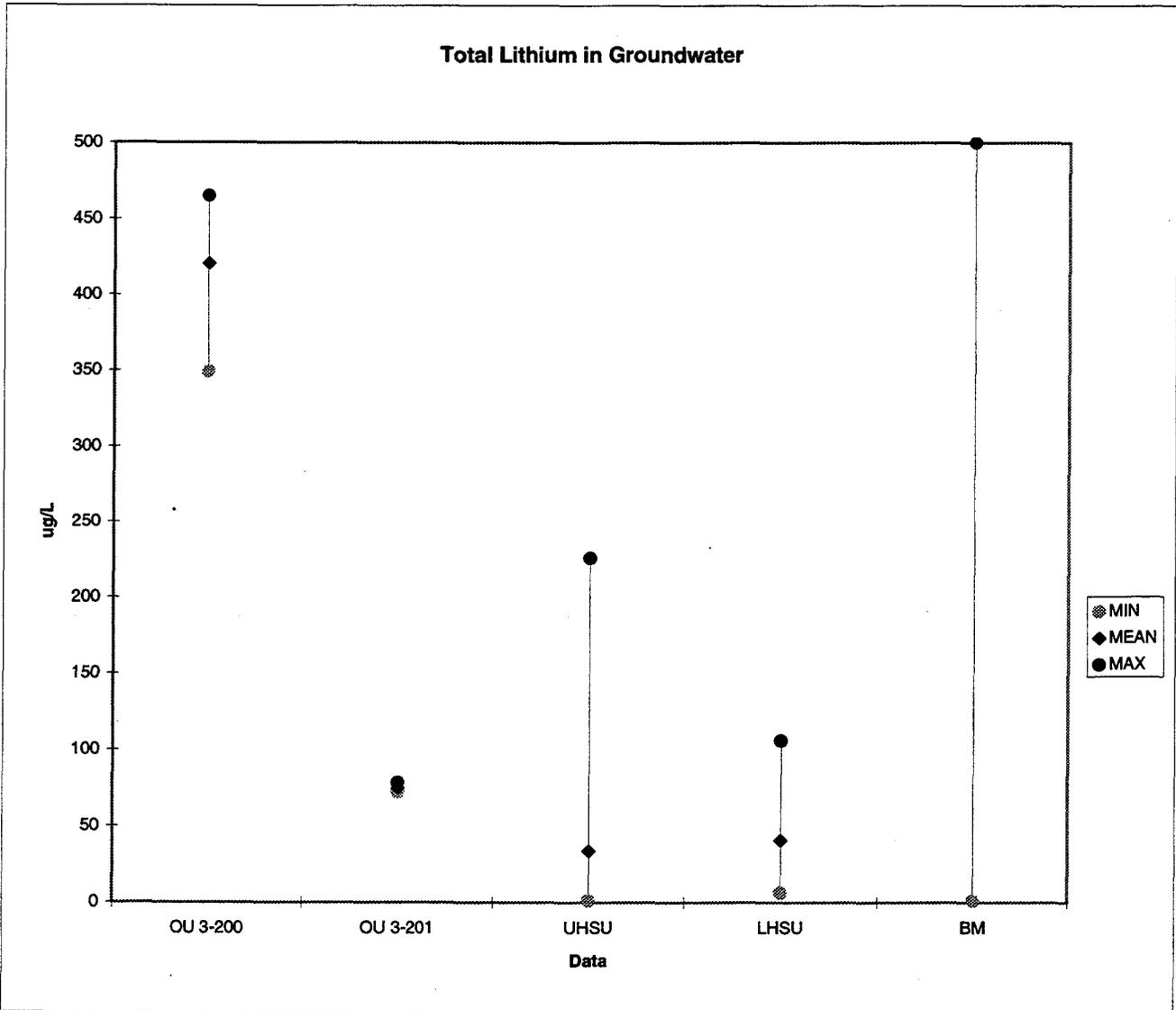
Lithium in Well 49192 is detected in levels greater than the upper background mean and maximum. The mean concentration of lithium is 420.5  $\mu\text{g/L}$  and the maximum concentration is 465  $\mu\text{g/L}$  compared to the UHSU mean and maximum concentration of 33.8 and 226  $\mu\text{g/L}$ , respectively. Lithium is typically found in micas associated with pegmatites and often replaces magnesium. After lithium is released because of weathering, it stays principally in solution. According to Matthes (1982), groundwater concentrations of lithium range from 1 to 500  $\mu\text{g/L}$ . The lithium concentrations for Well 49192 fall within this range. Figure 7-7 presents the OU 3 data for lithium.

As a pharmaceutical product, lithium is used for the treatment of depression and is administered in doses of approximately 150 to 2,400 mg/day, depending on the age, size, and physical condition of the patient (Allen, 1994). Toxic effects have been observed at doses of 300 mg/day. The maximum concentration in OU 3 groundwater is 465  $\mu\text{g/L}$ , resulting in a daily intake of less than 1 mg/day (assuming 2 liters of water are consumed per day). Since this is well below the therapeutic dose, lithium is not considered a COC. This is supported by the Phase 1 Health Studies, which did not identify lithium as a material of concern (CDPHE, 1991b).

**TOTAL LITHIUM IN GROUNDWATER**

(µg/L)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3-200	349	420.5	465	39	OU 3 Well 49192 (8 sampling events) (OU 3 Database)
OU 3-201	72.2	74.85	78.6	2.06	OU 3 Well 49292 (8 sampling events) (OU 3 Database)
UHSU	1.1	33.75	226	48.76	Weathered Claystone, BGCR (DOE, 1993c)
LHSU	6.2	40.69	106	29.29	Unweathered Arapahoe and Laramie Formation, BGCR (DOE, 1993c)
BM	1		500		Benchmark Data (Matthess, 1982)



Notes: If blank, no data are available.

OU 3-200 = IHSS 200 in OU 3.

UHSU = Upper hydrostratigraphic unit.

LHSU = Lower hydrostratigraphic unit.

BM = Benchmark.

**Figure 7-7**  
**TOTAL LITHIUM IN GROUNDWATER**

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#### Well 49292 (IHSS 201) – Lithium

The mean (74.9  $\mu\text{g/L}$ ) concentration for lithium in Well 49292 is less than the background mean plus two standard deviations (99.27  $\mu\text{g/L}$ ). The maximum value (78.6  $\mu\text{g/L}$ ) detected in the well is less than the maximum value detected in the background (106  $\mu\text{g/L}$ ) data set (see Figure 7-7) for the LHSU. The maximum value detected in Well 49292 is also less than the maximum value found in literature for metals naturally occurring in groundwater (illustrated in Figure 7-7). Based on the similarity of the OU 3 data to background and benchmark data, and the fact that lithium is not considered a potential contaminant from the RFETS, lithium has been eliminated as a COC. This is supported by the Phase 1 Health Studies, which did not identify lithium as a material of concern (CDPHE, 1991b).

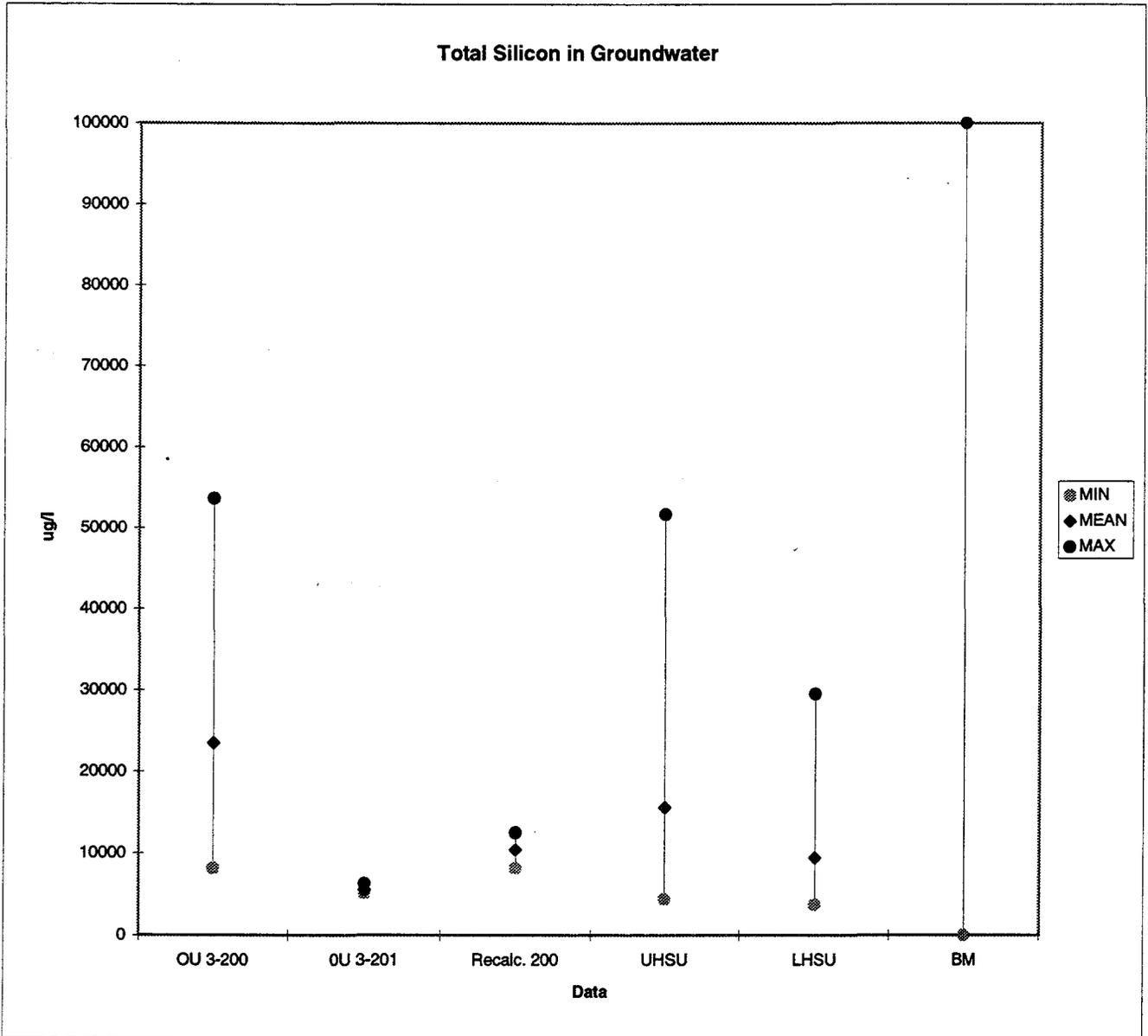
#### Well 49192 (IHSS 200) – Silicon

The mean (23,485  $\mu\text{g/L}$ ) for silicon in Well 49192 is less than the value of background mean plus two standard deviations (37,159  $\mu\text{g/L}$ ). The maximum value (53,600  $\mu\text{g/L}$ ) detected in the well is similar to the maximum value detected in the UHSU background (51,650  $\mu\text{g/L}$ ) data set and less than the maximum value seen in the literature (100,000  $\mu\text{g/L}$ ) (Dragun, 1988). The three greatest detections of silicon correlate with the three sampling events with elevated TSS (Figure 7-3). When the OU 3 mean concentration of silicon is recalculated, excluding the data with elevated TSS, the mean is 10,416  $\mu\text{g/L}$  and is below the UHSU mean (15,565  $\mu\text{g/L}$ ). Figure 7-8 presents the OU 3 data for silicon compared to the background data and illustrates the similarity of the data sets. The toxicity of silicon is usually associated with the inhalation of silica dust. Based on the similarity of the data sets, the nontoxic effects through ingestion, and the fact that silicon has not been identified as a potential RFETS contaminant, silicon has been eliminated from the COC list. Silicon is not on the Phase 1 Health Studies Materials of Concern list of potential contaminants from the RFETS (CDPHE, 1991b).

**TOTAL SILICON IN GROUNDWATER**

(µg/L)

DATA	MIN	MEAN	MAX	STD DEV	COMMENTS/SOURCE
OU 3-200	8140	23485	53600	18505	OU 3 Well 49192 (8 sampling events) (OU 3 Database)
OU 3-201	5110	5535	6260	432	OU 3 Well 49292 (8 sampling events) (OU 3 Database)
Recalc. 200	8140	10416	12500		OU 3 Well 49192 recalculated without sampling events associated with high TSS
UHSU	4399	15565	51650	10797	Weathered Claystone, BGCR (DOE, 1993c)
LHSU	3720	9427.5	29500	6631.12	Unweathered Arapahoe and Laramie Formation, BGCR (DOE, 1993c)
BM	5		100000		Benchmark Data (Dragun, 1988)



Notes: If blank, no data are available.  
 OU 3-200 = IHSS 200 in OU 3.  
 UHSU = Upper hydrostratigraphic unit.  
 LHSU = Lower hydrostratigraphic unit.  
 BM = Benchmark.

**Figure 7-8**  
**TOTAL SILICON IN GROUNDWATER**

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## 7.7 CHEMICALS OF CONCERN

Based on the COC selection process and the weight-of-evidence evaluation, there are no COCs for groundwater.



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## 8.0 REFERENCES

This section is divided into two types of references: 1) published scientific literature and project-specific correspondence (Subsection 8.1); and 2) published and project-specific databases from numerous sources (Subsection 8.2).

Subsection 8.2 lists the data sources for tables and figures in Sections 1.0 through 7.0 of this document. For additional information on the preparation steps involved to create a database listed here, or other information on data sources, refer to Subsection A-2 in Appendix A of this document.

### 8.1 SCIENTIFIC LITERATURE AND PROJECT-SPECIFIC CORRESPONDENCE REFERENCES

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**ASI, 1990.** Advanced Sciences, Inc. Water-Yield and Water-Quality Study of Other Sources Tributary to Standley Lake and Great Western Reservoir, Rocky Flats Plant; Task 16 of the Zero-Offsite Water-Discharge Study. Final Report. December 18, 1990.

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## 8.2 PUBLISHED AND PROJECT-SPECIFIC DATABASES

**Arvada, 1994DB.** Arvada Department of Water and Environmental Quality Database.

**DB1.** OU 3 Database, Version 4/26/94 (Paradox filename: DA042694.db).

**DB2.** OU 3 Database, Version 6/10/94 (Paradox filename: DA061094.db).

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## APPENDIX A. DATA PREPARATION

### A-1.0 INTRODUCTION

The OU 3 database was developed to store and organize the data from environmental sampling programs at the RFETS and surrounding area that were used to prepare the RCRA Facility Investigation/Remedial Investigation (RFI/RI), including the Human Health Risk Assessment and the Environmental Evaluation, for OU 3. The OU 3 database is composed of data from the following sources:

- Rocky Flats Environmental Database System (RFEDS)
- 1983/84 Sediment Sampling Investigations data (DOE, 1991)
- Rock Creek Background Soil Samples (DOE, 1993a)
- Jefferson County Sampling Area Soil Samples (received from RFEDS)
- Background Geochemical Characterization Report (DOE, 1993b)
- Benchmark – Survey Data for Sample Points and Polygons

These sources provided the data sets in various formats; therefore, different procedures were used, depending on the data source, to prepare the data for use in the OU 3 database. This appendix describes the procedures followed for each data set.

The OU 3 database is managed according to the Data Management Plan (DOE, 1993c) developed for the OU 3 RFI/RI. The Data Management Plan describes in detail the data management system for the project and includes procedures for data management staff, computer hardware and software, data models and organization, data management, and data users.

The remainder of Appendix A describes the overall structure of the OU 3 database, data preparation steps, and quality control (QC) checks that were performed to generate the tables for the OU 3 database. Appendix A is organized into the following sections:

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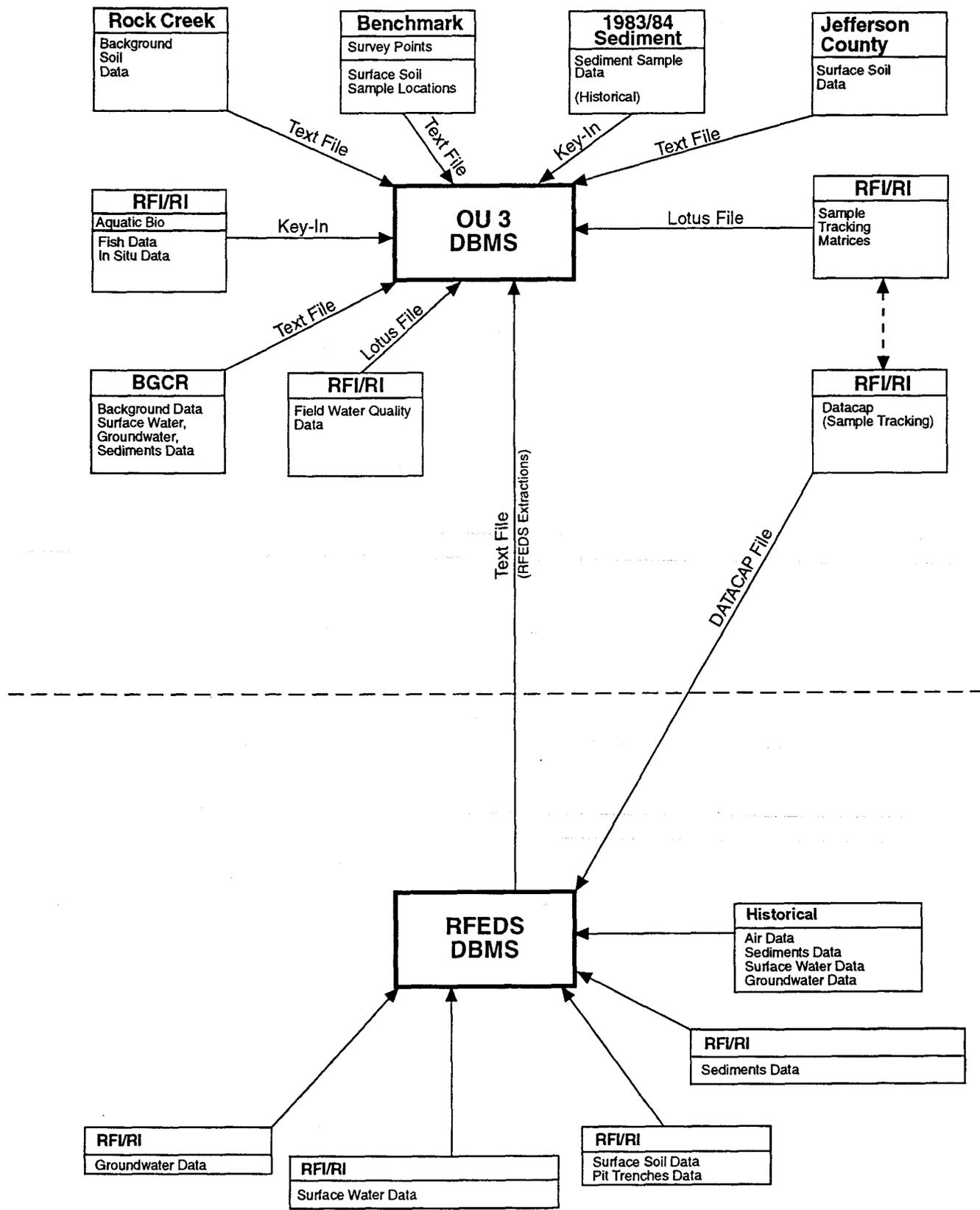
- OU 3 Database Structure
- RFEDS Data Preparation
- Additional Data Input
- Data Analysis Table
- Quality Control Checks

### **A-2.0 OU 3 DATABASE STRUCTURE**

The database management system uses a relational data model, where the data accessed by users are contained in a number of separate tables, but are related through one or more key fields. Tables were created for data sets from each of the sources listed above. Additionally, a Data Evaluation table was created to statistically compare OU 3 data and background data and to calculate summary statistics and risk estimates. The Data Evaluation table contains fields that reflect the application of data-evaluation protocols specified by EG&G (EG&G, 1994).

The OU 3 database was designed as a set of independent Paradox (DOS Version 4.0 RDMS) tables containing fields of data. These tables can be linked through key fields (i.e., selected fields that are common to two or more tables). Figure A-1 presents an organization diagram of the OU 3 database. Table A-1 summarizes the OU 3 database structure and describes the contents of each Paradox table. Figure A-2 lists the fields contained in each table and shows relationships between the tables. Table A-2 contains definitions of the various fields.

In addition to the Paradox tables, OU 3 data are contained in ARC/INFO files to be used for producing Geographical Information System (GIS) plots of analytical results and sample locations. Analytical result and sample location data were transferred to ARC/INFO using ASCII comma-separated files.



— Direct relationship  
 - - - Indirect Relationship

RFEDS = Rocky Flats Environmental Database System  
 RFI/RI = RCRA Facility Investigation/Remedial Investigation

BGCR = Background Geochemical Characterization Report (DOE, 1993c)  
 DBMS = Database Management System

**Figure A-1**  
**OU 3 DATABASE ORGANIZATION**

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**TABLE A-1**  
**OU 3 DATABASE STRUCTURE**

<b>Paradox Table Name</b>	<b>Paradox Table Description</b>
DA{date}.db	Data for the statistical background comparison tests and other data analysis tasks. Contains original sample data from tables DT012694, JT012694, NB012694 (excluding outliers as identified in the BGCR), and OT012694. Surface soil sampling results (CDPHE and MHM methods) are averaged for each location. Contains fields that reflect EG&G data analysis protocols for nondetects. Rejected data (Validation = R) and QC data are not included.
DG{date}.db	Sample locations (OU 3 and background) and data grouping information.
DB{date}.db	Original and QC data from RFEDS.
DT{date}.db	Original data only from RFEDS.
DQ{date}.db	QC data only from RFEDS.
JS{date}.db	Jefferson County Sampling Area surface soil data (original and QC data).
JT{date}.db	Jefferson County Sampling Area surface soil data (original data only).
JQ{date}.db	Jefferson County Sampling Area surface soil data (QC data only).
NB{date}.db	BGCR data for selected sample locations (non-seep sediment and surface water locations; weathered claystone monitoring well locations – original data only). Outliers, as identified in the BGCR, are included.
O1{date}.db	Rock Creek Background Soil data from OU 1 RI Report (original and QC data).
OT{date}.db	Rock Creek Background Soil data from OU 1 RI Report (original data only).
OQ{date}.db	Rock Creek Background Soil data from OU 1 RI Report (QC data only).

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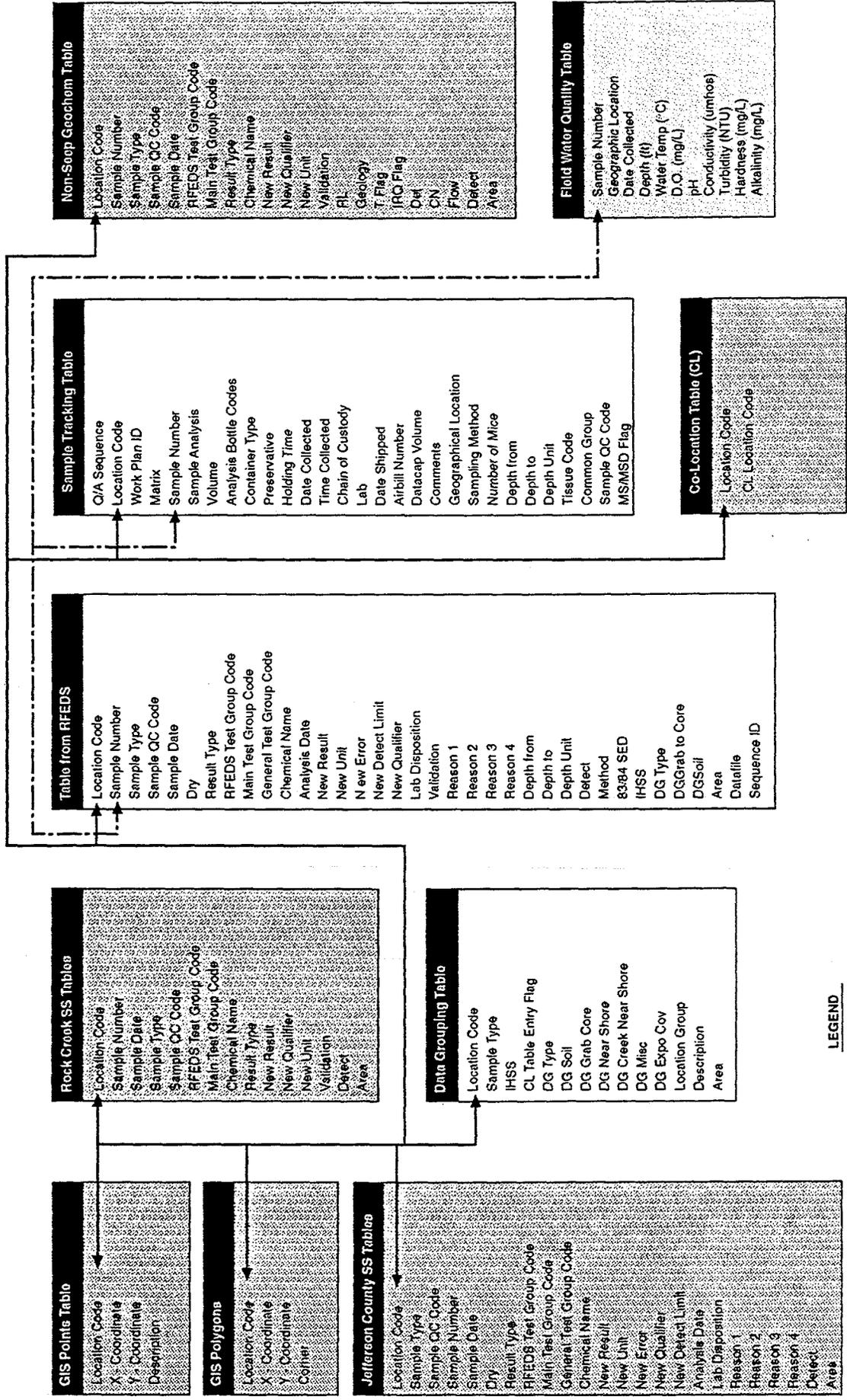
**TABLE A-1**  
**OU 3 DATABASE STRUCTURE**

<b>Paradox Table Name</b>	<b>Paradox Table Description</b>
ST{date}.db	Sample tracking information.
FW{date}.db	Field water quality data associated with BIO samples.
CL{date}.db	Matrix of co-located samples (e.g., co-located BIO, SW, and SED samples).

**Note:**

{date} = Each Paradox table filename includes the date on which the table was created and/or modified. Therefore, the most current tables were clearly identified and used for data manipulations. For example, Paradox file DA081094.db was modified on August 10, 1994.

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 CHECKED BY *Walter Livingston*  
 APPROVED BY *ME Borden*  
 05/13 7/20/94  
 DRAWING NUMBER 7/22/94



**LEGEND**

- Link by Sample Number
- - - Link by Sample Location Code
- ▭ Main Link Table for Tables with Relationships
- ▭ Related Tables to Sample Tracking
- ▭ Related Tables to Data Grouping
- ▭ Related to Both Main Link Tables

**Figure A-2**  
**OU 3 DATABASE TABLE**  
**RELATIONSHIP DIAGRAM**

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TABLE A-2  
OU 3 DATABASE FIELD NAME DEFINITIONS

Field Name	Definition
<b>DA Table</b>	
LOCATION CODE	Indicates environmental medium/physical location; can be more than one <b>LOCATIONCODE</b> at the same physical location. Example: BI100092 <-- Biology Location SD100092 <-- Sediment Location SW100092 <-- Surface Water Location are all at the same physical location.
SAMPLE TYPE	Designates environmental sample medium.
SAMPLE QC CODE	Codes a record as a REAL (i.e., original sample) or QC sample (e.g., DUP, FB).
SAMPLE NUMBER	Unique code designating a single sample taken at a <b>LOCATIONCODE</b> position; can be more than one sample number for a <b>LOCATIONCODE</b> .
SAMPLE DATE	Date sample was collected.
DRY	Denotes if sediment sample was dry at the time of collection.
RESULT TYPE	Codes a record as an original sample result (i.e., TRG = target) or a lab QC record (e.g., REP).
RFEDS TEST GROUP CODE	General chemical group code supplied by RFEDS; can be more than one <b>RFEDS TEST GROUP CODE</b> for an analytical method.
MAIN TEST GROUP CODE	Chemical group code; one code per analytical method.
GENERAL TEST GROUP CODE	General test that was performed on the sample.
CHEMICAL NAME	Analyte name.
ANALYSIS DATE	Date chemical analysis was performed.
NEW RESULT	Analytical result; validated result if available.

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**TABLE A-2**  
**OU 3 DATABASE FIELD NAME DEFINITIONS**

<b>Field Name</b>	<b>Definition</b>
ADJ RESULT	Adjusted result = One-half of the <b>RESULT FIELD</b> value (for nondetects only).
NEW UNIT	Unit associated with the result value.
NEW ERROR	Error term associated with radionuclide results.
NEW DETECT LIMIT	Detection limit (Detection limit = Instrument detection limit for OU 3 metals data Detection limit = Instrument detection limit or CRDL for BGCR metals data)
NEW QUALIFIER	Includes the qualifiers assigned by the laboratories and the data validators.
LAB DISPOSITION	If analytical results could not be transmitted, a reason disposition code is indicated.
VALIDATION	Validation codes assigned by the data validators. If the field is blank, the record has not been validated.
REASON1, REASON2, REASON3, REASON4	Explanation for validation codes.
DEPTH FROM	Upper boundary of a sediment core or pit trench segment.
DEPTH TO	Lower boundary of a sediment core or pit trench segment.
DEPTH UNIT	Unit for sediment core or pit trench segments.

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**TABLE A-2**  
**OU 3 DATABASE FIELD NAME DEFINITIONS**

Field Name	Definition
DETECT	<p>The detect field marks records that contain a 'U' in the <b>NEW QUALIFIER</b> field as a nondetect.</p> <p>Example:</p> <pre> NEWQUALIFIER      Detect UJ-----&gt;U J-----&gt;BLANK UU-----&gt;U *-----&gt;BLANK B-----&gt;BLANK UJ-----&gt;U           </pre>
ADJ DETECT	<p>Adjusted detect: Reflects application of EG&amp;G data analysis protocols. All radionuclides are designated as detects (i.e., <b>ADJ DETECT</b> field is BLANK); all B-qualified metals and water quality records are designated as detects. All other records with a "U" in the <b>DETECT</b> field are designated as nondetects (i.e., <b>ADJ DETECT</b> field contains a "U").</p>
METHOD	<p>Method used to collect a surface soil sample (CDH or MHM).</p>
84/85 SED FLAG	<p>Flags a record as belonging to the 1984/85 Sediment Sampling Investigations data set.</p>
IHSS	<p>Individual Hazardous Substance Site number</p>
DGTYPE	<p>Data grouping designation (e.g., CREEK, LAKE, PLOT, TRENCH).</p>
DGGRABCORE	<p>Data grouping designation for sediment samples indicating if GRAB or CORE sample.</p>
DGSOIL	<p>Data grouping designation for surface soil samples indicating if sample was located in the Remedy Acreage area.</p>
AREA	<p>Denotes if the record is background (B) or OU 3 site (S) data.</p>

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**TABLE A-2**  
**OU 3 DATABASE FIELD NAME DEFINITIONS**

Field Name	Definition
<b>Additional Fields - DG Table</b>	
CL TABLE ENTRY	Indicates if additional information for the record is available in the Co-Located Sample table.
DGNEARSHORE	Data grouping designation for sediment samples.
DGCREEKNEARSHORE	Data grouping designation for sediment samples.
DGMISC	Miscellaneous data grouping designation – empty field
DGEXPOCOV	Data grouping designation for sediment sample locations – exposed vs. covered with water.
GISID	I.D. code from ARC/INFO GIS data files.
GISSAMPLELOCATION	GIS map location.
LOCATIONGROUP	General geographic location group.
DESCRIPTION	Description of sample location based on medium and geographic location.

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### **A-3.0 RFEDS DATA PREPARATION**

EG&G maintains the RFEDS. The majority of data records in the OU 3 database were extracted by EG&G from RFEDS as ASCII text fixed-field files. EG&G began with an initial extraction of data from RFEDS on December 17, 1992, and throughout the duration of the project added periodic RFEDS extractions containing updated and additional records. The final extraction of RFEDS data for the Draft RFI/RI report was on February 15, 1994. All extractions, including those prior to February 15, 1994 (i.e., December 17, 1992; January 20, 1993; February 10, 1993; March 17, 1993; April 1, 1993; May 5, 1993; June 10, 1993; September 16, 1993; November 16, 1993), were imported from the text files into Paradox on February 16, 1994 to create the OU 3 database for the Draft RFI/RI report.

The steps necessary to import and prepare RFEDS data for the OU 3 database are described in detail below.

1. Convert RFEDS data-extraction files to ASCII separated/delimited format.
2. Import the extraction into Paradox.
3. Correct database inconsistencies and separate data that will not be used in quantitative data-analysis tasks.
4. Identify and resolve redundant data records.
5. Assemble the main cleaned-up table (without resolved problem records).
6. Produce potential problem records report.
7. Review potential problem records report and select records to be added back to the main table.

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8. Add selected record(s) from the review process back to the main table.
9. Copy main table to OU 3 database directory for RFETS.
10. Notify persons using OU 3 database of updated main table.

Note: In the description of preparation steps below, names of database fields are shown in all uppercase bold letters (e.g., **CHEMICAL NAME**, **MAIN TEST GROUP CODE**, and **NEW RESULT**).

**STEP 1** – Convert RFEDS data-extraction files to ASCII separated/delimited format.

The RFEDS data extraction format is ASCII column-delimited (i.e., text files that consist of fields that are of a fixed length). Because Paradox cannot import column-delimited ASCII files, the column-delimited RFEDS data files are converted to ASCII separated/delimited (DAT) files using a general-purpose conversion program written in PASCAL. ASCII separated/delimited files are text files that consist of fields separated by a special character, usually a comma. Additionally, the alpha fields are delimited with a special character (i.e., quotation marks for these data). Alpha fields are delimited with a special delimiter character so those fields can contain the special separator character as part of the alpha string (e.g., chemical names that contain commas).

**STEP 2** – Import the extraction into Paradox.

Using a custom script called IMPORTEX.SC, the DAT files are imported into Paradox. The imported data from the initial RFEDS extraction are put into a temporary table. The temporary table is then restructured to match the structure of the main raw data table, and the **SEQUENCE ID** field is used to link the temporary and main raw data tables. The temporary table records are then added to the main raw database table. The process is repeated for each extraction. Records from the source table (i.e., temporary table with RFEDS data) replace records in the destination table (i.e., main raw data table) if the **SEQUENCE ID** in the source table record already exists in the destination table. If the records from the source table are not

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in the destination table, then the records from the source table are added to the destination table.

**STEP 3** – Correct database inconsistencies and separate data that will not be used in quantitative data-analysis tasks.

Using a script named XCLEANUP.SC, the data are preprocessed to correct any inconsistencies found in the RFEDS data, such as the following:

- **CHEMICAL NAME** inconsistencies
- **RFEDS TEST GROUP CODE** name inconsistencies
- **Obsolete RFEDS TEST GROUP CODE** names
- **Unit** inconsistencies
- **Multiple fields of analytical data for one record (i.e., data received from RFEDS contain fields for laboratory results and corrected results from the data-validation subcontractor; some records contain both laboratory and corrected results).**

Additionally, the preprocessing step accomplishes the following:

- **Separation of historical data (i.e, pre-1992 data that tend to have QC problems) from OU 3 sampling program data; historical data will be used qualitatively in the RFI/RI report.**
- **Separation of QC data from original sample data; QC data will be used in the RFI/RI report to evaluate quality of the data; only original data will be used for all other quantitative data-analysis tasks.**
- **Removal of data for any samples not associated with the OU 3 field investigation.**

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XCLEANUP.SC performs the following operations:

#### **Separation of Historical Data**

Historical data are identified by the following Location Codes:

SW001 through SW004

SED001 through SED004

GS001 through GS004

These data are removed from the main raw-data table and placed into a separate table for use in the RFI/RI report.

#### **Separation of QC Data**

QC data are identified using the **SAMPLE QC CODE** field:

Any samples with codes in the **SAMPLE QC CODE** field other than REAL, BLANK, or UNK (i.e, unknown) are considered to be QC samples.

QC data are also identified using the **RESULT TYPE** field:

Any samples with codes in the **RESULT TYPE** field other than TRG, DIL, BLANK, or UNK are considered to be QC samples.

Data identified as QC samples are removed from the main raw data table and placed into a temporary table for further processing.

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### **Separation of Non-OU 3 Field Investigation Data:**

OU 3 field investigation data are identified by the following suffixes in entries in the **SAMPLE NUMBER** field:

- CH
- WCU3 or WC

Records with suffixes in the **SAMPLE NUMBER** field other than those listed above are not included in the OU 3 database.

### **Inconsistencies in Analyte Names**

Inconsistencies in analyte names (i.e., multiple names for the same chemical) found in the RFEDS data are corrected so that each chemical is listed by only one name in the OU 3 database (see Table A-3).

### **Obsolete RFEDS TEST GROUP CODES**

Obsolete codes in the **RFEDS TEST GROUP CODE** field consist of the following:

- PDMETCLP
- PDMETNOCLP

Any records with the codes listed above in the **RFEDS TEST GROUP CODE** field are removed from the main raw data table. RFEDS replaces these codes with new codes. Therefore, if records with test group codes of **PDMETCLP** and **PDMETNOCLP** are left in the table, they represent duplicate records.

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**TABLE A-3**  
**CHEMICAL NAME INCONSISTENCIES**

Multiple Chemical Names	Changed to
<b>RADIONUCLIDES</b>	
GROSS ALPHA - DISSOLVED GROSS ALPHA - SUSPENDED GROSS ALPHA PARTICLE ACTIVITY	GROSS ALPHA
GROSS BETA - DISSOLVED GROSS BETA - SUSPENDED GROSS BETA PARTICLE ACTIVITY	GROSS BETA
PLUTONIUM 239 PLUTONIUM 239/240	PLUTONIUM 239/240
URANIUM 233, 234 URANIUM 234	URANIUM 233/234
<b>WATER QUALITY</b>	
CYANIDE CYANIDE, AMENABLE CYANIDES ( SOLUBLE SALTS... )	CYANIDE
HEXAVALENT CHROMIUM CHROMIUM VI	HEXAVALENT CHROMIUM
NITRATE/NITRITE NITRATE/NITRITE ( HISTORICAL... )	NITRATE/NITRITE
ORTHOPHOSPHATE PARATHION, ETHYL ( INCORRECT CAS NUMBER CAUSED THIS TO BE LABELED INCORRECTLY - VERIFIED BY BETH MONTANO/EG&G )	ORTHOPHOSPHATE
SOLIDS, NONVOLATILE SUSPENDED TOTAL DISSOLVED SOLIDS	TOTAL DISSOLVED SOLIDS
TOTAL SOLIDS TOTAL SUSPENDED SOLIDS	TOTAL SUSPENDED SOLIDS
BICARBONATE BICARBONATE AS $\text{CaCO}_3^*$	BICARBONATE AS $\text{CaCO}_3$

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**TABLE A-3**  
**CHEMICAL NAME INCONSISTENCIES**

Multiple Chemical Names	Changed to
CARBONATE CARBONATE AS CaCO <sub>3</sub>	CARBONATE AS CaCO <sub>3</sub>
ALKALINITY AS CaCO <sub>3</sub> TOTAL ALKALINITY	ALKALINITY AS CaCO <sub>3</sub>

Note:

• = BICARBONATE AS CaCO<sub>3</sub> = BICARBONATE \* 1.22

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### Unit Inconsistencies

Any inconsistencies in units for a particular medium and test group code are converted to the appropriate consistent units (e.g., all results for dissolved metals analyses are expressed in units of  $\mu\text{g/L}$ ). This step is performed so that data for one chemical can be combined for quantitative data-analysis tasks such as calculation of summary statistics.

### Multiple Fields of Analytical Data

The main raw data table can contain data from the laboratory and from the data validation subcontractor for the same record. Validated data, if available, are placed in the OU 3 database. The following fields contain corresponding data from the two sources:

#### LABORATORY

RESULT  
QUALIFIER  
UNIT  
DETECT LIMIT  
ERROR

#### DATA VALIDATORS

VRESULT  
VQUAL  
VUNIT  
VDETECT  
--NO FIELD--

The protocols listed below are used to incorporate data from the laboratory and data validators:

- If the VRESULT field in the RFEDS data contains a result, then the value from VRESULT is placed in a new field (i.e., NEWRESULT) in the OU 3 database.

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- If the **VRESULT** field in the RFEDS data is blank, the value in the **RESULT** field is placed in the **NEWRESULT** field in the OU 3 database.
- The **UNIT**, **DETECT LIMIT**, and **ERROR** fields are treated the same as the **VRESULT** and **RESULT** fields. **NEW UNIT**, **NEW DETECT LIMIT**, and **NEW ERROR** fields were created in the OU 3 database to contain the data selected by the protocol described above.
- The **QUALIFIER** and **VQUAL** fields from the RFEDS data are concatenated in a **NEWQUALIFIER** field in the OU 3 database.

The **NEW RESULT**, **NEW UNIT**, **NEW DETECT LIMIT**, **NEW ERROR**, and **NEW QUALIFIER** fields are used for quantitative data-analysis tasks.

#### **Inconsistencies in the RFEDS TEST GROUP CODES**

The RFEDS data contain multiple codes in the **TEST GROUP CODE** field for the same general group of chemicals. Two new fields were created in the OU 3 database, **MAIN TEST GROUP CODE** and **GENERAL TEST GROUP CODE**, to standardize the grouping of chemicals into main sample preparation/analytical method categories (e.g., **DMETAL-CLP-NONCLP** refers to dissolved metals) and general chemical categories (e.g., **METALS** refers to both dissolved and total metal analyses), respectively. Table A-4 summarizes codes used in the **RFEDS TEST GROUP CODE** field and corresponding codes in the **MAIN TEST GROUP CODE** and **GENERAL TEST GROUP CODE** fields in the OU 3 database.

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**TABLE A-4**  
**RFEDS TEST GROUP CODE INCONSISTENCIES**

<b>RFEDS Test Group Code</b>	<b>Main Test Group Code</b>	<b>General Test Group Code</b>
BNACLCP	SVOA-ORG-CLP	SVOAS
CLHERB615	CL-HERB-EPA615	PESTICIDES
DMETADD	DMETAL-CLP-NONCLP	METALS
DIOX613	DIOX-PEST-EPA613	PESTICIDES
DPEST613	DIOX-PEST-EPA613	PESTICIDES
DMETCLPTAL	DMETAL-CLP-NONCLP	METALS
DMETNOCLP	DMETAL-CLP-NONCLP	METALS
DRADS	DISSOLVED-RADS	RADIONUCLIDES
DMETCLP	DMETAL-CLP-NONCLP	METALS
DSMETCLP	DMETAL-CLP-NONCLP	METALS
METADD	METAL-CLP-NONCLP	METALS
RFIN	WATER-QUALITY	WATER-QUALITY
METCLP	METAL-CLP-NONCLP	METALS
PAHCOM610	PAH-PEST-PCB-EPA610	PESTICIDES
PEST608	OCLPEST-EPA608	PESTICIDES
PESTCLP	PESTICIDE-CLP	PESTICIDES
PHPEST610	PAH-PEST-PCB-EPA610	PESTICIDES
PSTCLPTCL	PESTICIDE-CLP	PESTICIDES
PSTPCB508	PEST-PCB-EPA508	PESTICIDES
RFME	METAL-CLP-NONCLP	METALS
RFMS	DMETAL-CLP-NONCLP	METALS
RFPP	PESTICIDE-CLP	PESTICIDES
SMETCLP	METAL-CLP-NONCLP	METALS
RFRA	TOTAL-RADS	RADIONUCLIDES
SELCOM625	SVOA-ORG-CLP	SVOAS

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**TABLE A-4**  
**RFEDS TEST GROUP CODE INCONSISTENCIES**

<b>RFEDS Test Group Code</b>	<b>Main Test Group Code</b>	<b>General Test Group Code</b>
RFVO	VOA-ORG-CLP	VOAS
SELCO502.2	VOA-EPA502.2	VOAS
RFSV	SVOA-ORG-CLP	SVOAS
TRADS	TOTAL-RADS	RADIONUCLIDES
RFRS	DISSOLVED-RADS	RADIONUCLIDES
TRIPES619	TRIPEST-EPA619	TRIPESTICIDES
SMETNOCLP	METAL-CLP-NONCLP	METALS
SVOCLPTCL	SVOA-ORG-CLP	SVOAS
SMETCLPTCL	METAL-CLP-NONCLP	METALS
VOA502.2	VOA-EPA502.2	VOAS
VOACLPTCL	VOA-ORG-CLP	VOAS
VOCCLPTCL	VOA-ORG-CLP	VOAS
WQPL	WATER-QUALITY	WATER-QUALITY
OCLPEST608	OCLPEST-EPA608	PESTICIDES

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**STEP 4** – Identify and resolve redundant data records.

Step 4 of the cleanup process is designed to identify and remove redundant records from the OU 3 database and also uses the script XCLEANUP.SC. Step 4 includes the following procedures:

- A. The main table is broken into subsets (i.e., Radionuclides, Metals, Volatile Organic Compounds, Pesticides, and Water-Quality parameters), and the algorithm described below is performed for each subset of data. For each subset, additional tables are created (i.e., a KEEP table for records that will be retained in the OU 3 database and REJECT tables) that require further processing.
  
- B. The records in the subset table to be processed are sorted in the following order:
  - 1. **SAMPLE NUMBER**
  - 2. **CHEMICAL NAME**
  - 3. **MAIN TEST GROUP CODE**
  
- C. As each subset table is parsed, all records having the same entries in the **SAMPLE NUMBER, CHEMICAL NAME, and MAIN TEST GROUP CODE** fields are copied to a temporary table. When the entries in the **SAMPLE NUMBER, CHEMICAL NAME, and MAIN TEST GROUP CODE** fields change, processing moves to Step 4-D, 4-F, or 4-G, depending on the type of records contained in the temporary table. When processing returns to Step 4-C, it continues with the next group of records having the same **SAMPLE NUMBER, CHEMICAL NAME, MAIN TEST GROUP CODE**, until all records have been processed.

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D. If the temporary table includes one validated record, the following protocols are used:

- The records in the temporary table are placed in a REJECT table if the **NEW RESULT** field (and **ERROR** field if the Radionuclides subset table is being processed) is blank for all records.
- The validated record is placed in the KEEP table if the **NEW RESULT** field of the validated record contains a value. All nonvalidated records in the temporary table are placed in a REJECT table.

Processing returns to Step 4-C.

E. If the temporary table includes more than one validated record, the following protocols are used:

- One of the validated records is placed in the KEEP table if the validated records have identical values in the **NEW RESULT** field. All other validated and nonvalidated records are deleted.
- If the **RESULTS** field of the records in the temporary table are not identical or are blank, all records in the temporary table are placed in a REJECT table.

Processing returns to Step 4-C.

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F. If the temporary table contains one nonvalidated record, the following protocols are used:

- The record is placed in the KEEP table if the **RESULT** field (and **ERROR** field if the Radionuclides subset table is being processed) is not blank.
- The record is placed in a REJECT table if the **RESULT** field is blank.

Processing returns to Step 4-C.

G. If the temporary table contains more than one nonvalidated record, the following protocols are used:

- One of the nonvalidated records is placed in the KEEP table if the values in the **RESULT** field (and **ERROR** field if the Radionuclides subset table is being processed) are identical.
- All of the records in the temporary table are placed in a REJECT table if the **RESULT** fields are not identical or blank.

Processing returns to Step 4-C.

Tables that are created by Step 4 include:

RADS.db	Radionuclide subset table
RDKEEP.db	KEEP table for the Radionuclides subset
RDREJ61.db	Radionuclides REJECT table (validated record; <b>RESULT</b> and/or <b>ERROR</b> field is blank)

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- RDREJ62.db Radionuclides REJECT table (one validated record kept; all corresponding nonvalidated records placed in this table)
- RDREJ63.db Radionuclides REJECT table (more than one validated record; no duplicate results; all records rejected)
- RDREJ64.db Radionuclides REJECT table (one nonvalidated record rejected; **RESULT** field blank)
- RDREJ65.db Radionuclides REJECT table (more than one nonvalidated record; no duplicate results; all records rejected)

Step 4 is also followed to create corresponding tables for the Metals, Volatile Organic Compounds, Pesticides, and Water-Quality parameters.

**STEP 5** – Assemble the main cleaned-up table.

In Step 5 of the cleanup process, all of the KEEP tables are assembled into one table (i.e., DT{date}.db.; {date} indicates the date when the table was assembled or updated).

**STEP 6** – Produce potential problem records report.

Hardcopy reports of the rejected records are made from the REJECT tables for each subset of data (e.g., Radionuclides, Metals, etc.). These reports are used to resolve problems with data records.

**STEP 7** – Resolve problem records.

EG&G data-management staff review data-problem reports and resolve the problem or redundant records. The following list summarizes the resolution of the types of data problems found after importing RFEDS data extractions on February 16, 1994:

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- Blank **RESULT** field for Cesium-137: These records were nondetects and the value presented in the **DETECTION LIMIT** field should also be used in the **RESULT** field.
- Blank **ERROR** field for Plutonium-239/240: EG&G provided value.
- Redundant nonvalidated records for Total Organic Carbon analysis: EG&G provided RFEDS ID number of the records to be retained in the OU 3 database; other records for the same sample number were deleted.
- Nonvalidated results for surface soil samples: EG&G used nonvalidated records; validation could take from 1 to 6 months.

The following protocols are used for redundant validated records:

- If analysis dates are different for redundant records, the record with the most recent date is selected for the OU 3 database.
- If the analysis dates are the same for redundant records, selection of the record to be used in the OU 3 database is based on the Reason Codes associated with the Validation Codes.

**STEP 8** – Create final database tables.

Corrected problem records and records selected from a group of redundant records for use in the OU 3 database are added to the DT{date}.db table.

**STEP 9** – Copy main table to the OU 3 database directory for RFETS.

The updated DT{date}.db table is copied to the OU 3 database directory for RFETS.

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**STEP 10** – Notify persons using OU 3 database of updated main table.

Persons using OU 3 data are notified of the new table with a DATABASE UPDATE form.

Steps 3 through 10 are repeated with a modified cleanup script using QC data that were separated from original sample data during the cleanup process. The DQ{date}.db table is then created using cleaned-up QC data.

**A-4.0 ADDITIONAL DATA INPUT**

Additional data were entered into the OU 3 database to supplement the data extracted from RFEDS, including data from the following sources:

- 1984/85 Sediment Sampling Investigation (DOE, 1991) (see Attachments 1 and 2 for a discussion of analyses performed to determine the useability of these data in the RFI/RI report for OU 3).
- Rock Creek Background Soil Samples (DOE, 1993a).
- Jefferson County Sampling Area Soil Samples.
- Background Geochemical Characterization Report (DOE, 1993b).
- Benchmark – Survey Data for Points and Polygons.

These additional data were received in various formats, and different procedures were used to prepare the data for use in the OU 3 database, depending on the source. Table A-5 summarizes the dates received, format, and types of data and data preparation procedures for each of these sources.

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Table A-5  
 Additional Data Sources

Source Name	Format	Description	Preparation Procedures
1983/84 Sediment Sampling Investigations Data (DOE, 1991)	Hardcopy data	1984 sediment data for IHSS 200 and IHSS 201	<ol style="list-style-type: none"> <li>1. Enter data into Paradox</li> <li>2. Perform 100% QC check of Paradox data against hardcopy data</li> <li>3. Create table of data (SL{date}.db)</li> </ol>
Rock Creek Background Soil Data (DOE, 1993a)	Hardcopy tables	Background surface soil data for 18 locations; radionuclides	<ol style="list-style-type: none"> <li>1. Enter data into Excel</li> <li>2. Perform 100% QC check of Excel output against hardcopy data</li> <li>3. Import data to Paradox</li> <li>4. Create Paradox tables for data users (OT{date}.db-original samples, OQ{date}.db-QC samples, and O1{date}.db-all samples)</li> </ol>

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Table A-5  
 Additional Data Sources

Source Name	Format	Description	Preparation Procedures
Jefferson County Sampling Area Soil Data (extracted from RFEDS)	ASCII file (Column-delimited)	Surface soil sampling results for 47 sample locations; Am-241 and Pu-239/240	<ol style="list-style-type: none"> <li>1. Convert data to comma-separated/ alpha field-delimited files</li> <li>2. Import files to Paradox</li> <li>3. Run data through preprocessing and cleanup scripts</li> <li>4. Create Paradox tables for data users (JT{date}.db-original samples , JQ{date}.db-OC samples, and JS{date}.db)-all samples)</li> </ol>
Background Geochemical Characterization Report Data (DOE, 1993b)	ASCII files (Column-delimited)	Background data for stream surface water, stream sediments, and groundwater	<ol style="list-style-type: none"> <li>1. Convert data to comma-separated/ alpha field-delimited files</li> <li>2. Import files to Paradox</li> <li>3. Remove seep locations, correct inconsistent units/chemical names</li> <li>4. Create Paradox table (NB{date}.db)</li> </ol>

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Table A-5  
 Additional Data Sources

Source Name	Format	Description	Preparation Procedures
Benchmark Survey Data	ASCII files (Comma-separated)	Survey coordinates for sample points and polygons (surface soil plots)	<ol style="list-style-type: none"> <li>1. Import data into Paradox</li> <li>2. Convert coordinates to state plane coordinates</li> <li>3. Create table for points (BP{date}.db)</li> <li>4. Create table for polygons (BY{date}.db)</li> </ol>

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## A-5.0 DATA ANALYSIS TABLE

The Data Analysis table (DA{date}.db) is composed of records from the DT{date}.db, JT{date}.db, OT{date}.db, and NB{date}.db tables. Additionally, the DA{date}.db table contains fields that reflect application of data-evaluation protocols. This section describes the data-evaluation protocols and outlines the procedures used to prepare the DA{date}.db table.

### A-5.1 Data Evaluation Protocols

The data-evaluation protocols for the Draft RFI/RI report are based on Guidance for Data Useability in Risk Assessments (EPA, 1990) and a guidance memorandum from EG&G (EG&G, 1994, included as Attachment 3). The eleven protocols described in this section are the data manipulation rules that were applied to prepare the DA{date}.db table for quantitative data analysis tasks. The protocols were designed to identify and eliminate data considered unacceptable for quantitative data analysis (e.g., data rejected as a result of data validation). Additionally, the protocols provide for consistent treatment of nondetects, QC samples, and other specific categories of data in the quantitative data analyses.

#### A-5.1.1 Nonvalidated Data

Any nonvalidated data in the OU 3 database were included in the DA{date}.db table and were used for quantitative data-analysis tasks for the Draft RFI/RI report. A total of 1,082 records in the OU 3 database used for the COC selection process (7 percent) were nonvalidated.

#### A-5.1.2 Validated/Qualified Data

All data qualified with a "J," and any other qualifiers except those with an "R," in the **VALIDATION** or **NEWQUALIFIER** fields were included in the DA{date}.db table and were used in the quantitative data analysis tasks for the Draft RFI/RI report. Validated data flagged with an "R" in the **VALIDATION** field or nonvalidated data flagged with an "R" in the **NEWQUALIFIER** field were not included in the DA{date}.db table and therefore were not used in any

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quantitative data analyses tasks for the Draft RFI/RI report. Data flagged with an "R" are rejected because they did not meet performance requirements in the sample or in the associated QC samples. The R-qualified data may be used qualitatively in the RFI/RI report, if appropriate.

#### A-5.1.3 QC Samples

All QC samples (e.g., trip blanks, field duplicates, laboratory replicates, etc.) were removed from the DA{date}.db table and were not used for quantitative analysis tasks for the RFI/RI report. The QC data were used to evaluate precision, accuracy, representativeness, comparability, and completeness (PARCC) under the RFI/RI Task 4.

#### A-5.1.4 Treatment of Detects/Nondetects for Inorganic Parameters

Analytical results for metals and water-quality parameters were treated as detects if the following conditions applied:

- The **NEWQUALIFIER** field is blank.
- A sample is not qualified with a "U" in the **NEWQUALIFIER** field. A sample qualified with a "U" is a nondetect and is below the instrument detection limit.
- A sample is qualified with a "B" in the **NEWQUALIFIER** field. The "B" qualifier signifies that the analytical result was below the contract-required reporting limit (CRDL) but above the instrument detection limit (IDL). B-qualified data are considered to be detects and are used as such.

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#### **A-5.1.5 Treatment of Nondetects – Volatiles, Semivolatiles, Pesticides, and PCBs**

When applying any parametric analytical test, one-half the reported analytical result (the **NEWRESULT** field in the database) was used for organic samples flagged with a "U" in the **NEWQUALIFIER** field. All data flagged with a "U" were counted as nondetects when performing detection frequency calculations.

When applying any nonparametric analytical test, the reported analytical result (the **NEWRESULT** field in the database) was used for organic samples flagged with a "U" in the **NEWQUALIFIERS** field.

#### **A-5.1.6 Treatment of Nondetects – Radionuclides**

DOE Order 5400.xy provides guidance on the treatment of radionuclide results at or below the detection limit. The DOE order states: "All of the actual values, including those that are negative, *should* be included in the statistical analyses. Practices such as assigning a zero, the detect limit value, or some in-between value to the below-detectable data point, or discarding those data points can severely bias the resulting parameter estimates and *should* be avoided. ... Data from censored distributions are more amenable to standard statistical analyses than are those from truncated distributions ...."

Based on the DOE guidance, all radionuclide results were treated as detects for quantitative data-analysis tasks except for calculation of detection frequency. For calculating detection frequency, all results flagged with a "U" in the **NEWQUALIFIER** field were counted as nondetects.

#### **A-5.1.7 Treatment of Negative and Zero Results for Radionuclides**

Based on DOE Order 5400.xy, all radionuclides results, including negative and zero values, were used in quantitative data-analysis tasks. For statistical tests requiring log-transformations of the radionuclide results (e.g., background statistical comparison tests), the distributions of

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results for a particular analyte for both OU 3 data and background data were shifted by adding a constant value to each result so that all results were positive. This shift was performed because calculation of the natural log of zero or negative values results in an error. Therefore, negative and zero values could not be included in the comparison test when log-transformation was required if the shift was not performed.

#### A-5.1.8 Treatment of Error

The impact of the **ERROR** reported for the radionuclide parameters will be discussed in the RFI/RI Uncertainty Section. In cases where the **ERROR** is equal to or greater than 0.5 times the **NEWRESULT** value, there is less confidence in the reported result and a higher degree of uncertainty. For example, if the error is subtracted from the result, the reported value may be less than the detection limit. Data that fall in this category will be identified but not altered for quantitative data-analysis tasks.

#### A-5.1.9 Treatment of Outliers

An outlier is an extreme observation that does not conform to the pattern established by other observations and is unlikely to be a valid member of the population of interest. An outlier may be the result of an incorrectly read, recorded, or transcribed measurement; an incorrect calculation; an error in documentation (field or laboratory); or an actual environmental condition. To evaluate the presence of outliers, the following procedure was applied to the analytes, by sample type, for the sediment, surface-water, and groundwater background data in the Background Geochemical Characterization Report (DOE, 1993b) only (this screening process was not applied to OU 3 data):

1. Anomalous data were flagged.
2. These flagged values were examined, then checked individually if judged to be geochemically questionable. Each flagged outlier was evaluated with respect to the historical trend of the data for that specific location, as well as laboratory

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conditions such as matrix interference, in an attempt to determine why the datum was aberrant.

3. If the outlier resulted in a correctable error, the value was changed, and the correct value was included in the data set. Data that were believed to have resulted from laboratory contamination (e.g., acetone "hits"), irresolvable transcription errors, or other noncorrectable errors that gave results not thought to be representative of background were excluded from subsequent statistical analyses.

Outliers listed in Appendix E of the Background Geochemical Characterization Report have been excluded from the DA{date}.db table of the OU 3 database and therefore, were not used in statistical comparison tests.

#### **A-5.1.10 Averaging of Analytical Results for Surface Soil Samples Collected Using Different Methods**

Surface-soil samples were collected by two different methods: the Colorado Department of Public Health and the Environment (CDPHE) method and the RFETS/Modified Hazel method (MHM). The paired t-test at the 95 percent confidence level showed that the results from these two methods were not significantly different (see Attachment 4 for a detailed discussion of the statistical analysis). Therefore, results of the two methods for a sample location were averaged and this mean value for the sample location was entered into the DA{date}.db table of the OU 3 database in the NEWRESULT field for use in quantitative data-analysis tasks.

#### **A-5.2 PREPARATION OF DATA-ANALYSIS TABLES**

The following procedures were used to prepare the DA{date}.db table:

1. A copy of the DT{date}.db table was made and named DT2DA.db.

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2. The "Rejected" (**VALIDATION** field contains an "R") data records were removed from the DT2DA.db table.
3. The units were checked for consistency.
4. The codes in the **CHEMICAL NAME** field were checked for consistency.
5. A **DETECT** field was added to the table. The **DETECT** field indicates if a record is a nondetect (U) or a detect ([BLANK]). If the **NEW QUALIFIER** field contained a "U," then the **DETECT** field for the corresponding record contains a "U;" otherwise, the **DETECT** field was left blank.
6. An **AREA** field was added to the table. The **AREA** field denotes if the record is background (B) or OU 3 site (S) data. For the DT2DA.db table, the **AREA** field was set to "S" to denote that it is OU 3 site data.
7. The data from the DT2DA.db table were inserted into the DA{date}.db table.

Procedures 1 through 7 were repeated for the JT{date}.db, OT{date}.db, and NB{date}.db tables. After all tables were combined into the DA{date}.db table, the following procedures were performed:

8. The DA{date}.db table was checked for overall consistency of units.
9. The DA{date}.db table was checked for overall consistency of codes in the **CHEMICAL NAME** field.
10. Fields from the data grouping table (DG{date}.db) were added to the DA{date}.db table. Using the **LOCATION CODE** field as a link from the DA{date}.db to the DG{date}.db, the **IHSS**, **DGTYPE**, **DGGRABCORE**, and **DGSOIL** were linked into the DA{date}.db table.

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11. New fields (i.e., **ADJ DETECT** and **ADJ RESULT**), based on the data-evaluation protocols, were set up in the DA{date}.db table. The values in the **DETECT** and **NEW RESULT** fields were copied into the **ADJ DETECT** and **ADJ RESULT** fields so that both sets of fields contained the same data. The ADJ fields were then adjusted to reflect application of the data evaluation protocols, and the original fields were not changed.
12. For all radionuclide records, the **ADJ DETECT** field was set to a [BLANK] value to denote the record as a detect value.
13. For all metal records, if the **NEW QUALIFIER** field contained a "B," then the **ADJ DETECT** field value was set to a [BLANK] value to denote the record as a detect.
14. For all records that contained a "U" in the **ADJ DETECT** field after completing procedures 12 and 13, the value in the **ADJ RESULTS** field was replaced with a proxy value (i.e., one-half of the value in the **NEW RESULT** field).
15. The updated DA{date}.db table was copied to a separate directory.
16. Persons using OU 3 data were notified of the updated DA{date}.db table with a DATABASE UPDATE form.

#### A-6.0 QUALITY CONTROL CHECKS

The following QC checks were performed to verify the completeness and consistency of the OU 3 database:

- A QC audit of the ST{date}.db table was performed using printouts of the original source data. Any error or inconsistencies found in the ST{date}.db table were corrected.

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- A list of missing data (i.e., data requested from the laboratories but not contained in the DT{date}.db or DQ{date}.db tables) was produced by comparing the ST{date}.db table (i.e., sample tracking matrix that contains all requested analyses for each sample number) to the DT{date}.db and the DQ{date}.db tables. The records listed on the missing data list were checked against the RFEDS data received from EG&G to verify that all data received from RFEDS were imported into the OU 3 database.
- SAMPLE LOCATION codes in the DB{date}.db, DG{date}.db, and DA{date}.db tables for OU 3 field investigation data were compared to SAMPLE LOCATION codes in the ST{date}.db table. No inconsistencies were found between SAMPLE LOCATION codes in the tables.
- The DA{date}.db and DB{date}.db tables were checked for consistency of analytical result units for each CHEMICAL NAME. Records with inconsistent units were corrected.
- The DA{date}.db table was queried to verify it did not contain any QC samples or R-validated/qualified data. No QC samples or R-validated/qualified data were found.
- The DA{date}.db table was queried to verify it contained data for the following SAMPLE TYPES only: SS-surface soil plots, PT-pit trench soil samples, SW-surface water, SD-sediment, GW-groundwater, and BI-biota. These SAMPLE TYPES were found along with several records with "UN" (unknown) in the SAMPLE TYPE field. The records with "UN" were corrected.
- Sample locations contained in the DG{date}.db table for each medium were checked against the GIS plots to verify all sample-location data were transferred to ARC/INFO. Sample locations were found to be consistent between the DG{date}.db table and the GIS plots.

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- Ten percent of the analytical data displayed on the GIS plots was checked against the NEW RESULT field in the DA{date}.db table for corresponding sample locations to verify that the analytical data were accurately transferred to ARC/INFO. No errors were found in the analytical data on the GIS plots.

Additionally, a QC check of the cleanup script was performed using a sample data set that contained historical data, QC data, and redundant records. No errors were found in the data set after cleanup; historical records and QC data were separated, and redundant records were placed into the appropriate REJECT tables, as described in Subsection A-3.0.

## REFERENCES

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**ATTACHMENT 1 STATISTICAL COMPARISON OF 1983/1984 SEDIMENT  
DATA AND RFI/RI SEDIMENT DATA**

Note: The 1983/1984 sediment data are referred to as "Setlock historical" data in this memorandum.

# MEMORANDUM

CH2M HILL

**TO:** Amy Lange/DEN

**COPIES:** Mike Bedan/DEN  
Robert Scrimo/DEN

**FROM:** Susan Blake/DEN

**DATE:** July 23, 1993

**SUBJECT:** Statistical Comparison of Setlock and RFEDS Data

**PROJECT:** DEN30181.X1.08

The Setlock historical plutonium 239/240 sediment data for Standley Lake and Great Western Reservoir (GWR) has been statistically compared to the RFEDS plutonium 239/240 sediment sample data to determine if there is a significant difference in the means of the data sets. For the Standley Lake sediment data, there is not a significant difference in the means of the Setlock and RFEDS data sets at a 95% confidence level. The data could be combined for future data analysis. For the GWR sediment data, there is a significant difference in the means of the data sets. The GWR Setlock plutonium data should not be used for future data analysis.

The following describes the analytical method used. The data analyzed are shown in Attachment 1 to this memo. For four of the Standley Lake sample locations (SED09492, SED09592, SED09692, and SED09792) there are three RFEDS samples. In order to do a statistical t-test paired by location (as requested by EG&G), there needs to be one Setlock and one RFEDS sample value per location analyzed. To accommodate this, the RFEDS data was summarized two different ways. One way was to use the one RFEDS value at each of the four locations that was sampled in the same time frame as the other RFEDS data used (see column STRFRES in Attachment 1). The other way was to average the three RFEDS values at each of the four sample locations with more than one RFEDS value (see column RFEDSAV in Attachment 1).

A t-test for paired comparisons was performed to determine if there is a significant difference between the Setlock and RFEDS data. This comparison tests whether the mean of sample differences between pairs of data is significantly different from zero. The standard error over which this hypothesis is tested is the standard error of the mean difference.

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Attachment 2 shows the results of three comparisons using SYSTAT software:  
Standley Setlock vs. RFEDS (for same date samples at the four locations)  
Standley Setlock vs. RFEDS (for average samples at the four locations)  
GWR Setlock vs. RFEDS.

For each comparison, a probability is shown. This is the probability of seeing such a difference in the means of the two data sets given that the null hypothesis of the difference in the means being significantly different from zero is true. If the probability is high we do not reject the null hypothesis and conclude there is no significant difference in the means. If the probability is low, we reject the null hypothesis and conclude there is a significant difference in the means of the data sets.

For the Standley Lake comparisons it did not matter what sample values were used for the four locations with multiple RFEDS samples. Both comparisons showed the means are not significantly different with 95% confidence (PROB=0.530, 0.529). The GWR comparison shows the means to be significantly different with 95% confidence (PROB=0.026).

A review of the summary statistics for each of the data groups shown in Attachment 2 reflects these conclusions. The mean of the Standley Lake Setlock data (0.061) is not much different from the RFEDS data summarized two different ways (0.045). The mean of the GWR Setlock data (0.239) appears to be greater than the GWR RFEDS data (0.094).

The Standley Lake Setlock data can be appropriately combined with the RFEDS data for future data analysis. The GWR Setlock data should not be used for further data analysis.

RF OU 3 SETLOCK AND SAMPLE DATA

ATTACHMENT 1

SET LOC	RFEDS LO	SET RES	RFEDS RE	SETSTAN	RFSTAN	STSETRE	STRFRES	RFEDSAV	SETGWR	RFGWR	GWRSETR	GWRFRFE
SL-48	SED09492	0.047	0.00692	SL-48	SED09492	0.047	0.0241	0.02	GWR-EG01	SED12892	0.078	0.046
SL-48	SED09492	0.047	0.029	SL-33	SED09592	0.014	0.0186	0.0272	GWR-EG03	SED13092	0.064	0.0419
SL-48	SED09492	0.047	0.02409	SL-06	SED09692	0	0.013	0.0125	GWR-EG04	SED13192	0.056	0.106
SL-33	SED09592	0.014	0.017	SL-10	SED09792	0.05	0.0181	0.0131	GWR-EG09	SED13392	0.406	0.0827
SL-33	SED09592	0.014	0.0186	SL-29	SED09892	0.067	0.1895	0.1895	GWR-EG13	SED13492	0.237	0.103
SL-33	SED09592	0.014	0.04598	SL-47	SED09992	0.041	0.0599	0.0599	GWR-EG14	SED13592	0.278	0.14
SL-06	SED09692	0	0.013	SL-12	SED10092	0.005	0.0325	0.0325	GWR-EG16	SED13692	0.237	0.119
SL-06	SED09692	0	0.013	SL-17	SED10192	0.057	0.0391	0.0391	GWR-EG18	SED13792	0.157	0.106
SL-06	SED09692	0	0.01438	SL-09	SED10292	0.041	0.0324	0.0324	GWR-EG26	SED13992	0.407	0.0939
SL-10	SED09792	0.05	0.00212	SL-08	SED10392	0.029	0.0377	0.0377	GWR-EG28	SED14192	0.024	0.025
SL-10	SED09792	0.05	0.019	SL-45	SED10492	0.071	0.0367	0.0367	GWR-EG32	SED14392	0.14	0.125
SL-10	SED09792	0.05	0.01809	SL-35	SED10592	0.553	0.0726	0.0726	GWR-EG36	SED14492	0.013	0.0143
SL-29	SED09892	0.067	0.1895	SL-52	SED10692	0.027	0.0267	0.0267	GWR-EG35	SED14592	0.991	0.1533
SL-47	SED09992	0.041	0.0599	SL-42	SED10792	0.079	0.0447	0.0447	GWR-EG41	SED14692	0.065	0.0667
SL-12	SED10092	0.005	0.03251	SL-26	SED10892	0.018	0.017	0.017	GWR-EG33	SED14792	0.43	0.1872
SL-17	SED10192	0.057	0.03912	SL-30	SED10992	0.069	0.144	0.144				
SL-09	SED10292	0.041	0.03241	SL-01	SED11092	0	0.0011	0.0011				
SL-08	SED10392	0.029	0.03769	SL-38	SED11192	0.02	0.0153	0.0153				
SL-45	SED10492	0.071	0.03668	SL-37	SED11292	0.023	0.0599	0.0599				
SL-35	SED10592	0.553	0.0726	SL-40	SED11392	0.014	0.0117	0.0117				
SL-52	SED10692	0.027	0.02671									
SL-42	SED10792	0.079	0.0447									
SL-26	SED10892	0.018	0.01697									
SL-30	SED10992	0.069	0.144									
SL-01	SED11092	0	0.00112									
SL-38	SED11192	0.02	0.0153									
SL-37	SED11292	0.023	0.0599									
SL-40	SED11392	0.014	0.0117									
GWR-EG01	SED12892	0.078	0.046									
GWR-EG03	SED13092	0.064	0.0419									
GWR-EG04	SED13192	0.056	0.106									
GWR-EG09	SED13392	0.406	0.0827									
GWR-EG13	SED13492	0.237	0.103									
GWR-EG14	SED13592	0.278	0.14									
GWR-EG16	SED13692	0.237	0.119									
GWR-EG18	SED13792	0.157	0.106									
GWR-EG26	SED13992	0.407	0.0939									
GWR-EG28	SED14192	0.024	0.025									
GWR-EG32	SED14392	0.14	0.125									
GWR-EG36	SED14492	0.013	0.0143									
GWR-EG35	SED14592	0.991	0.1533									
GWR-EG41	SED14692	0.065	0.06668									
GWR-EG33	SED14792	0.43	0.1872									

# ATTACHMENT 2

PAIRED T-TEST OF SETLOCK DATA TO RFEDS SAMPLE DATA  
 1 7/23/93 1:17:30 PM A:\SET2.SYS

	STSETRES	STRFRES	RFEDSAVG
N OF CASES	20	20	20
MINIMUM	0.000	0.001	0.001
MAXIMUM	0.553	0.190	0.190
MEAN	0.061	0.045	0.045
STANDARD DEV	0.118	0.046	0.046

	GWRSETRE	GWRRFRES
N OF CASES	15	15
MINIMUM	0.013	0.014
MAXIMUM	0.991	0.187
MEAN	0.239	0.094
STANDARD DEV	0.253	0.049

PAIRED SAMPLES T-TEST ON STSETRES VS STRFRES WITH 20 CASES

MEAN DIFFERENCE = 0.017  
 SD DIFFERENCE = 0.115  
 T = 0.640 DF = 19 PROB = 0.530

PAIRED SAMPLES T-TEST ON STSETRES VS RFEDSAVG WITH 20 CASES

MEAN DIFFERENCE = 0.017  
 SD DIFFERENCE = 0.116  
 T = 0.641 DF = 19 PROB = 0.529

PAIRED SAMPLES T-TEST ON GWRSETRE VS GWRRFRES WITH 15 CASES

MEAN DIFFERENCE = 0.145  
 SD DIFFERENCE = 0.225  
 T = 2.498 DF = 14 PROB = 0.026

**ATTACHMENT 2**  
**REVISION TO STATISTICAL COMPARISON OF 1983/1984 SEDIMENT**  
**DATA AND RFI/RI SEDIMENT DATA**

Note: The 1983/1984 sediment data are referred to as "Setlock historical" data in this memorandum.

MEMORANDUM

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TO: Michael Guillaume/EG&G

COPIES: Greg Williams/TT CORP  
Karen Wiemelt/CH2M HILL  
Amy Lange/CH2M HILL  
Mike Bedan/CH2M HILL

FROM: Susan Blake/CH2M HILL

DATE: November 10, 1993

SUBJECT: Revision to Statistical Comparison of Setlock and OU3 RFI/RI Data

PROJECT: DEN30181.X1.08

#### INTRODUCTION/PURPOSE

The Setlock historical plutonium 239/240 sediment data for Standley Lake and Great Western Reservoir (GWR) are statistically compared to the OU3 RFI/RI plutonium 239/240 sediment sample data to determine if it is appropriate to combine the Setlock data with the OU3 RFI/RI data for further data analysis.

This memorandum is a revision to the original analysis performed in July (reference memorandum dated 7/23/93). The original analysis was performed using a paired t-test. The OU 3 Work Plan (reference 21100-WP-OU3.1, section 6, revision 1, p. 29) specifies that the analysis will be performed using another type of paired analysis; referred to in the Work Plan as the Sign test. However, the statistical test described in the OU 3 Work Plan is known as the Wilcoxon signed rank test. There is another statistical test for paired data called the Sign test but it is not the test described in the Work Plan. The Sign test is less efficient than other statistical tests for detecting true differences between data sets (Snedecor and Cochran, 1989). Therefore, the paired t-test and Wilcoxon signed rank test are used for this analysis. This memorandum summarizes the results of the paired t-test and Wilcoxon signed rank test.

#### APPROACH

The hypothesis tested is that the Setlock historical plutonium activity levels are greater than or equal to the OU3 RFI/RI plutonium activity levels. The Setlock and OU3 RFI/RI data are matched by sample location and therefore treated as paired data. The null hypothesis is that the median of the population of paired differences is equal to zero. The alternative hypothesis is the median difference is not equal to zero.

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If the null hypothesis is not rejected (i.e., the median differences equal zero), then it is concluded that the Setlock historical data are not significantly different from the OU3 RFI/RI sample data and the data are combined for further analysis. If the null hypothesis is rejected, then it is concluded that the Setlock data are significantly different from the OU3 RFI/RI sample data. Further analysis would then be performed to determine if the Setlock data are significantly higher or lower than the OU3 RFI/RI data. If the Setlock data are significantly higher the data are still combined with the OU3 RFI/RI data for further analysis. This approach is conservative in that higher historical plutonium activity levels will increase the OU3 RFI/RI activity levels. If the Setlock data would be significantly lower than the OU3 RFI/RI data a reevaluation of the data would be performed as this would be an unexpected result.

Two different types of statistical comparisons for paired data are performed. The paired t-test is a parametric test that assumes the population of the differences in the pairs are normally distributed and compares the mean of the population of paired differences to zero. (In a normal distribution the mean is the same as the median.)

The Wilcoxon signed rank test is a nonparametric test that makes no distributional assumptions about the data. This test determines whether the median of the population of paired differences is equal to zero. The test is more efficient than the t-test for detecting differences in the two groups of data when the data are not normally distributed. The Wilcoxon signed rank test is also appropriate for when the population of the paired differences in the data have heavy-tailed distributions and contain outliers (Snedecor and Cochran, 1989).

The comparison approach is the same whether using a paired t-test or Wilcoxon signed rank test. For each comparison, a probability is shown. This is the probability of observing the results of the two data sets given the null hypothesis that there is no difference in the medians (means) is true. If the probability is high, we do not reject the null hypothesis and conclude there is no significant difference in the medians. If the probability is low, we reject the null hypothesis and conclude there is a significant difference in the medians of the data sets.

## ANALYSIS

The GWR and Standley Lake sediment plutonium data are shown in Tables 1 and 2, respectively. In Table 2, four of the Standley Lake sample locations (SED09492, SED09592, SED09692, and SED0972) have three OU3 RFI/RI samples per location which were collected on different dates. In order to perform a statistical test with

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data paired by location, there needs to be one Setlock and one OU3 RFI/RI sample value per location analyzed. To accomodate this, the OU3 RFI/RI data are summarized two different ways. One way is to use the one OU3 RFI/RI value at each of the four locations that was sampled in the same time frame as the other OU3 RFI/RI data used. The other way is to average the three OU3 RFI/RI values at each of the four sample locations. These two ways of summarizing the data for analysis are shown in Table 2. Not all of the Setlock plutonium data available are used in these analyses. Only those samples which have a corresponding OU3 RFI/RI sample are used.

TABLE 1. GWR SEDIMENT PLUTONIUM ACTIVITY DATA

SETLOCK SAMPLE #	OU3 RFI/RI SAMPLE #	SETLOCK (pCi/g)	OU3 RFI/RI (pCi/g)
GWR-EG01	SED12892	0.078	0.0460
GWR-EG03	SED13092	0.064	0.0419
GWR-EG04	SED13192	0.056	0.1060
GWR-EG09	SED13392	0.406	0.0827
GWR-EG13	SED13492	0.237	0.1030
GWR-EG14	SED13592	0.278	0.1400
GWR-EG16	SED13692	0.237	0.1190
GWR-EG18	SED13792	0.157	0.1060
GWR-EG26	SED13992	0.407	0.0939
GWR-EG28	SED14192	0.024	0.0250
GWR-EG32	SED14392	0.140	0.1250
GWR-EG36	SED14492	0.013	0.0143
GWR-EG35	SED14592	0.991	0.1533
GWR-EG41	SED14692	0.065	0.0667
GWR-EG33	SED14792	0.430	0.1872

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TABLE 2. STANDLEY LAKE SEDIMENT PLUTONIUM ACTIVITY DATA

SETLOCK SAMPLE#	OU3 RFI/RI SAMPLE#	SETLOCK (pCi/g)	OU3 RFI/RI (pCi/g)	OU3 RFI/RI. same date	OU3 RFI/RI. avg
SL-48	SED09492	0.047	0.00692, 0.029, 0.02409	0.02409	0.0200
SL-33	SED09592	0.014	0.017, 0.0186, 0.04598	0.0186	0.0272
SL-06	SED09692	0.000	0.01, 0.013, 0.01438	0.0130	0.0125
SL-10	SED09792	0.050	0.00212, 0.019, 0.01809	0.01809	0.0131
SL-29	SED09892	0.067	0.1895	0.1895	0.1895
SL-47	SED09992	0.041	0.0599	0.0599	0.0599
SL-12	SED10092	0.005	0.0325	0.0325	0.0325
SL-17	SED10192	0.057	0.0391	0.0391	0.0391
SL-09	SED10292	0.041	0.0324	0.0324	0.0324
SL-08	SED10392	0.029	0.0377	0.0377	0.0377
SL-45	SED10492	0.071	0.0367	0.0367	0.0367
SL-35	SED10592	0.553	0.0726	0.0726	0.0726
SL-52	SED10692	0.027	0.0267	0.0267	0.0267
SL-42	SED10792	0.079	0.0447	0.0447	0.0447
SL-26	SED10892	0.018	0.0170	0.0170	0.0170
SL-30	SED10992	0.069	0.1440	0.1440	0.1440
SL-01	SED11092	0.000	0.0011	0.0011	0.0011
SL-38	SED11192	0.020	0.0153	0.0153	0.0153
SL-37	SED11292	0.023	0.0599	0.0599	0.0599
SL-40	SED11392	0.014	0.0117	0.0117	0.0117

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The paired t-test and Wilcoxon signed rank test are used to make the following comparisons:

- GWR Setlock vs. GWR OU3 RFI/RI
- Standley Setlock vs. Standley OU3 RFI/RI (same date samples)
- Standley Setlock vs. Standley OU3 RFI/RI (average samples).

The results of the paired t-test are shown in Table 3. The mean and standard deviation of the differences are shown for each comparison. These statistics are used to calculate a T-statistic that is used with the degrees of freedom (equal to the number of samples minus one) to determine the probability of seeing such a result given the null hypothesis that the mean of the differences is zero.

TABLE 3. RESULTS OF PAIRED T-TEST

COMPARISON	DIFF MEAN	DIFF SD	T-STAT	DF	PROB	DIFF?
GWR Setlock vs. OU3 RFI/RI	0.145	0.225	2.498	14	0.026	YES
Standley Setlock vs. OU3 RFI/RI, same date samples	0.017	0.115	0.640	19	0.530	NO
Standley Setlock vs. OU3 RFI/RI, avg of samples	0.017	0.116	0.641	19	0.529	NO

The GWR comparison shows the means to be significantly different with 95% confidence (i.e., PROB=0.026 is less than 0.05). For the Standley Lake comparisons it does not matter what sample values are used for the four locations with multiple OU3 RFI/RI samples. Both comparisons show the means are not significantly different with 95% confidence (i.e., PROB=0.530, 0.529 are greater than 0.05).

Table 4 shows the results of the Wilcoxon signed ranks test. This nonparametric approach calculates a Z-statistic based on ranks of the data. This Z-statistic is used to determine a probability using normal approximation. This is the probability of seeing such a result given the null hypothesis that the median of the paired differences is zero.

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TABLE 4. RESULTS OF WILCOXON SIGNED RANKS TEST

COMPARISON	Z-STATISTIC	PROBABILITY	DIFFERENCE?
GWR Setlock vs. OU3 RFI/RI	-2.669	0.008	YES
Standley Setlock vs. OU3 RFI/RI, same date samples	-0.075	0.940	NO
Standley Setlock vs. OU3 RFI/RI, avg of samples	-0.019	0.985	NO

The GWR comparison shows the medians to be significantly different with 95% confidence (PROB=0.008 is less than 0.05). For the Standley Lake comparisons it does not matter what sample values are used for the four locations with multiple OU3 RFI/RI samples. Both comparisons show the medians are not significantly different with 95% confidence (PROB=0.940, 0.985 greater than 0.05).

A review of the summary statistics for each of the data groups shown in Table 5 reflects these conclusions. The mean and median of the Standley Lake Setlock data are not much different from the OU3 RFI/RI data summarized two different ways. The mean and median of the GWR Setlock data appear to be greater than the GWR OU3 RFI/RI data.

TABLE 5. SUMMARY STATISTICS FOR SETLOCK AND OU3 RFI/RI DATA

STATISTIC	STANLEY SETLOCK	STANLEY OU3 RFI/RI (same date)	STANLEY OU3 RFI/RI (avg)	GWR SETLOCK	GWR OU3 RFI/RI
No. of cases	20	20	20	15	15
Minimum	0.000	0.001	0.001	0.013	0.014
Maximum	0.553	0.190	0.192	0.991	0.187
Mean	0.061	0.045	0.045	0.239	0.094
Median	0.035	0.032	0.032	0.157	0.103
Std. Dev.	0.118	0.046	0.046	0.253	0.049

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CONCLUSION/SUMMARY

The Setlock data are compared with the OU3 RFI/RI data for Standley Lake and Great Western Reservoir using two different statistical tests (paired t-test and Wilcoxon signed rank test). Both statistical tests show no significance difference in the Setlock and OU3 RFI/RI data for Standley Lake at 95% confidence. Both statistical tests results show a significant difference in the Setlock and OU3 RFI/RI data for Great Western Reservoir at 95% confidence. However, the mean and median activity level of the GWR Setlock plutonium data are higher than the GWR OU3 RFI/RI plutonium data.

Based on these results, the Setlock data for both GWR and Standley Lake can be appropriately combined with the OU3 RFI/RI data for future data analyses.

**NOTE:** The only background data that should be used (for OUs 3 through 16) in the OU v. Background comparisons, are those ASCII files dated 9-30-93 or later. Previous information regarding instrument detection limits, and earlier file generations of the background data should be discarded.

### PRACTICAL SUGGESTIONS FOR USERS OF RFEDS DATA (3-28-94)

The standard RFEDS output format changed on February 21, 1994. The old output format is given here as Appendix A; the new output format is given here as Appendix B.

In general, there are actually three related issues that may arise for users of RFEDS data:

- (1) How to deal with multiple detection limits
- (2) How to treat non-detects
- (3) How to perform data cleanup

#### 1.0 MULTIPLE DETECTION LIMITS

The standard reporting format for RFEDS data (through 1993) gives one field for the reported detection limit. Unfortunately, this one field may contain either of three variables; the instrument detection limit (**IDL**), the method detection limit (**MDL**), or the contract-required detection/quantitation limit (**CRDL/CRQL**). The significance of these three different types of detection limits is that, for inorganic analytes (i.e., metals and water-quality parameters), the CRDL may be one to two orders of magnitude greater than the corresponding IDL for a particular analyte.

The "Gansecki rule" was proposed (in EPA comments on the *1990 Background Geochemical Characterization Report*) as an attempt to eliminate the high-value non-detects from the data set. The "Gansecki rule" calls for exclusion of all non-detects greater than two times the minimum reporting limit; however, this "rule" has come under criticism as arbitrary and possibly not technically defensible.

#### 1.1 Summary and Recommendations

- \* Decisions based on a graphical review of the data distribution are thought to be more technically defensible than the general application of an arbitrary rule (i.e. the "Gansecki rule"), even if the "rule" comes from EPA comments. The use of professional judgement and technically arguable reasoning are recommended in place of the "Gansecki rule." It is incumbent upon the data users to document all steps in their analysis of RFEDS data.

EG&G will review the graphics jointly with the subcontractor, and provide guidance at this point in the data analysis.

\* The values of CRDLs for metals, as given in EPA SOW for Inorganics Analysis, should be compared with the data set to ascertain what percentage of the data is reported as the value of the CRDL (see Table 1). EG&G will review the data jointly with the subcontractor, and give directions on how to proceed.

Table 1: INORGANIC TARGET ANALYTE LIST (TAL)

Analyte	CRDL (ug/L)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

## 2.0 TREATMENT OF NON-DETECTS

For those data sets containing censored data, the method of replacement affects the value obtained for the mean and upper confidence limit (UCL). The mean and skewness generally increase in deviation from the true values, as the proportion of non-detects increases. The deviation from true mean value is also greater as the amount of skewness increases. Maximum Likelihood Estimation (MLE) generally does a better job of estimating skewness than does simple substitution.

Sanford *et al.* (1993) tested the "accuracy" of different replacement methods for non-detects, evaluating the accuracy of different methods by the root mean square error and by a scoring system. Sanford *et al.* (1993) concluded that the performance of the different replacement methods were, as follows:

### SCORING OF DIFFERENT REPLACEMENT METHODS

	<u>MLE</u>	<u>Simple Sub.</u>	<u>Drop Non-detects</u>
40% Non-detects	93%	89%	64%
80% Non-detects	61%	54%	29%

Therefore, for as much as 80-percent non-detects, simple substitution and MLE have been shown to have similar "strength" (see Sanford *et al.*, 1993). In cases with greater than 80-percent non-detects, the results obtained from simple substitution and MLE may be quite different, and can lead to different — possibly opposite — conclusions.

Certainly the *worst* possible treatment of non-detects is to drop them from the data set (Helsel, 1990; Sanford *et al.*, 1993). Non-detects should **NEVER** be excluded from any statistical comparison of OU versus background data.

Given the cumulative uncertainties throughout the processes of sampling and chemical analysis, the possible error introduced by using simple substitution rather than using MLE replacement of non-detects is probably acceptable. The standard practice for treatment of non-detects, as given in EPA statistical guidance for RCRA sites (1989, 1992), calls for simple substitution using  $\frac{1}{2}$  the detection limit, for non-detect rates of as much as 15 percent.

## 2.2 Summary and Recommendations

- \* Data for which all unit designations are blank, should be deleted from the working data set if it is not possible to obtain verification of units.
- \* As a replacement value for any non-detect prior to standard statistical analyses, the data user may choose to do the following:
  - > Use  $\frac{1}{2}$  the reported detection limit, for replacement of non-detects.
  - > Maximum-likelihood methods (see Helsel, 1990), in which non-detects are fitted to a distribution and assigned a range of values, may also be used as a method of replacing non-detects. (NOTE: This method does require the analyst to choose a distribution — either lognormal or normal — to assign values to non-detects. The analyst should also be aware of back-transformation bias in the case of log-transformed data.)

Based on the study of Sanford *et al.* (1993) and EPA CERCLA guidance, the

recommendation of EG&G is to use  $\frac{1}{2}$  the reported detection limit as a replacement value for analytes with as much as 80-percent non-detects. For analytes with a non-detect rate of greater than 80 percent, the use of inferential statistical analysis is not recommended. EG&G will provide additional guidance for treatment of these high-rate non-detects.

\* All data for radionuclides should be used as detects, except for rejected data (validation code = R). For liquid samples, radionuclide data are generally given in units of PCI/L; for solids, radionuclide data are in PCI/G, except for TRITIUM data, which are always in units of PCI/L.

\* For organics, the result qualifier should be used to determine the percentage of non-detects. Non-detects for organic analytes are generally qualified "U", but other designations may also appear in the result-qualifier field (for additional information about result qualifiers (see attached Appendix C).

"Hits" of some common lab contaminants such as acetone, methylene chloride, and certain phthlates may indicate contamination if detected in the associated lab blank; such sample results are designated by a "B" in the result-qualifier field. EPA guidance for risk assessment (1989 EPA/540/1-89/002) indicates that if the concentration of a common lab contaminant in a sample is more than 10 times the concentration of the same analyte in the blank, then the sample result is taken to be a real "hit", not just lab contamination. For other analytes that are not typically found as lab contaminants, EPA guidance (EPA, 1989) states that if the concentration in the sample exceeds 5 times the concentration in the blank, then the sample result is taken to be a real "hit", not just lab contamination.

\* For metals and water-quality parameters, it may be ineffective to rely on the result qualifier alone. The following criteria have been employed to differentiate detects from non-detects, and are suggested as guidelines for the data:

- > If the result-qualifier field contains a "U", the result is taken as a non-detect (i.e., censored data point).
- > If the result-qualifier field is blank, the result is used as a detected value, barring evidence to the contrary.
- > If the result qualifier (for inorganics) is "B" (indicating that the result was above the IDL but below the CRDL), the result is taken to be a detected value (see Appendix C).
- > Other characters also are found in the qualifier field, and, barring any other evidence to the contrary, these are generally accepted as detects.

\* All data should be reviewed graphically (non-detects and detects together) prior to the application of any statistical tests. This will help to illustrate any potential problems, such as high-value non-detects (e.g., non-detect values reported as the value of the CRDL). If questions arise, EG&G will give guidance to the subcontractor after jointly reviewing the graphical presentations of the data.

### 3.0 ISSUES REGARDING DATA CLEANUP

The so-called "data cleanup" of RFEDS output is mostly a task to make the data consistent. This consists of a time-consuming series of steps (which should be documented by the data user) including the standardization of units, standardization of geologic codes, standardization of locations if the location designation has changed over time, standardization of analyte names (usage has changed over the years), deletion of blank "form-generated" records for which no results are given, exclusion of QC data (rinsates, etc.) from the working data set, removal of any rejected (val = 'R') data, replacement of non-validated records with corresponding validated records (if available), correction of incorrect units (e.g., pH should have 'PH' as the unit, *not* 'MG/L' as the unit), treatment of qc DUP/REAL pairs, appropriate use of DIL data, outlier analysis, etc.

Upon receipt of RFEDS data, the user should verify the field positions of all variables in the RFEDS ASCII output file. After verification, the ASCII file may be transformed into data files for a specific software (e.g., SAS, Lotus, Excel, SPSS, etc.) to be used in the data manipulation. It is recommended that the user create successive generations of the data files rather than just continually updating the original data file; this simplifies data analysis if back-tracking is required for any reason.

Successive generations of data files may proceed as follows (this is just a suggestion):

- (1) Original data files created from RFEDS ASCII files; these files contain the entire RFEDS data pull, including QC samples, rejected data, etc.
- (2) Second generation of data files, drop QC samples (except qc DUPs of DUP/REAL pairs), rejected data, blank form-generated records, tentatively identified compounds (TICs), etc. Create new variables, using validated data (where available) to supersede non-validated results, units, qualifiers, and detection limits. Standardize units within each analyte suite. Note that in the old RFEDS output format (Appendix A) there were variable fields entitled "Qualifier" (lab qualifier), "Validation" (the validation code), and "VQual" (the validation qualifier). The validation qualifier ("VQual") should supersede the lab qualifier ("Qualifier"). **The validation code ("Validation") is a code, not a qualifier.**

In the new RFEDS output format (i.e., data extracted after February 21, 1994), the validation qualifier ("VQual") field is not present; rather, the validated qualifier will automatically replace the lab qualifier ("Qualifier"). The validation code field ("Validation") will still indicate whether the datum is acceptable (Validation = A, V, or JA), or rejected (Validation = R), or other.

Standardize location names if designations have changed over time (check cross-reference listings of well location names, etc.). Standardize geologic codes. Standardize analyte names (e.g. "PLUTONIUM-239,240" = "PLUTONIUM-239/240", etc.). (NOTE: standardization of analyte names and units should now be automatic in the new RFEDS data output).

- (3) From (1), create a separate file with QC data for analysis of data quality. Check the PARCC parameters (precision, accuracy, representativeness, completeness, and comparability).
- (4) **NOTE: The averaging of qc DUP/REAL pairs may be too time-consuming to perform, and will most likely result in insignificant changes to numerical values. The following suggested averaging of qc DUP/REAL pairs should be done at the analyst's discretion.**

From (2), create a third generation of data files with averaged DUP/REAL pairs (change REAL value to the mean value of the averaged DUP/REAL pair, then delete the DUP record). In the case of DUPs with no corresponding REAL record, change "DUP" to "REAL". (NOTE: Prior to averaging of DUP/REAL pairs, sort the data by LOCATION, SAMPLE NUMBER, SAMPLE DATE, and ANALYTE. This should bring together all existing DUP/REAL pairs).

Treatment of DIL data requires the data analyst to find the analyte(s) that necessitated the dilution; these should have a qualifier of "E" (for exceedance). The DIL result(s) for the E-qualified analyte(s) should be used in the data analysis; other analytes may have results reported for the DIL sample analysis, but these results should be deleted if these analytes in the original undiluted sample were NOT qualified as "E".

Outlier analysis, and exclusion of identified outliers from data analysis, may not be allowable by the regulatory agencies. That is, it is easy to argue that an extremely high value in background is probably an outlier that can be excluded from data analysis, but it is difficult to argue that an extremely high value in an OU is an outlier rather than contamination.

The RFEDS has shown continuous improvement in the quality of data contained in the system. Newer data (1992-93) are generally "cleaner" than historic (pre-1992) data. However, all data users need to be made aware of potential pitfalls before applying statistical tests to the data. The steps listed in the previous paragraph give a general overview for the process of data cleanup.

### 3.1 Summary and Recommendations

- \* All data users should carefully document the steps used in the process of data cleanup. If questions arise, review of this documentation should be able to provide the necessary information; otherwise contact your EG&G project manager for additional information.
- \* RFEDS and the Sample Management Group are committed to Continuous Improvement; recent data (1992 to present) have fewer problems than historic data (pre-1992). Issues of duplicate records, incorrect units, etc., are currently being addressed.

The new RFEDS program for uploading data now runs automatic checks to ensure

standardization of units and analyte names, checks to ensure that appropriate QC samples are included, and checks for completeness of analyte suites.

#### 4.0 REFERENCES

Helsel, D.R. (1990). Less than obvious: statistical treatment of data below the detection limit. *Environmental Science & Technology*, v. 24, n. 12, p. 1766- 1774.

Sanford, R.F., Pierson, C.T., and Crovelli, R.A. (1993). An objective replacement method for censored geochemical data. *Mathematical Geology*, v. 25, n. 1, p. 59-80.

U.S. Environmental Protection Agency (February, 1989). *Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities, Interim Final Guidance*. EPA/530-SW-89-026.

U.S. Environmental Protection Agency (July, 1992). *Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance*.

## BASIC ANALYTICAL DATA EXTRACTION FORMAT DESCRIPTION

The output file from a standard data extraction is ASCII format, column delimited with spaces used to fill out column width. An additional space has been added between columns for legibility.

The requested data extraction has the following column format:

FIELD	STARTING POSITION	FIELD LENGTH
Location	1	15
Sample Number	17	20
Project Name	38	15
Sample Type	54	2
Sample QC Code	57	4
Sample QC Partner	62	20
Sample Date	83	9
Laboratory	93	5
Lab Batch Id	99	15
Analysis Date	115	9
Test Group Code	125	10
Result Type	136	3
Chemical	140	40
Parameter Code	181	11
Run Number	193	3
Count Number	197	3
Lab QA Code	201	4
Lab Sample Number	206	10
Result Qualifier	217	1
Result	219	10
Unit Measure	230	10
Error	241	10
Qualifier	252	5
Detect Limit	258	10
Validation	269	2
Reason1	272	3
Reason2	276	3
Reason3	280	3
Reason4	284	3
VResult	288	10
VUnit	299	10
VQual	310	5
VDetect	316	10
Validation Date	327	9
Sequence Id (RFEDS ID)	337	10

RFEDS BASIC ANALYTICAL  
DATA EXTRACTION FORMAT DESCRIPTION  
2/14/94

The output file from a standard data extraction is ASCII format, column delimited with spaces used to fill out column width. An additional space has been added between columns for legibility.

The requested data extraction has the following column format:  
ADDITIONAL SPACE = 1

FIELD	STARTING POSITION	FIELD LENGTH
Location	1	15
Sample Number	17	20
Project Name	38	15
Sample Type (type)	54	2
Sample QC Code (qc)	57	4
Sample QC Partner	62	20
Sample Date (sdate)	83	9
Laboratory	93	5
Lab Batch Id	99	15
Analysis Date	115	9
Test Group Code (group)	125	10
Result Type (id)	136	3
Chemical	140	40
Parameter Code	181	11
Run Number	193	3
Count Number	197	3
Lab QA Code	201	4
Lab Sample Number	206	10
Result Qualifier	217	1
Result	219	10
Unit Measure (units)	230	10
Error	241	10
Qualifier (qual)	252	5
Detect Limit (detect)	258	10
Validation (val)	269	2
Reason1 r1	272	3
Reason2 r2	276	3
Reason3 r3	280	3
Reason4 r4	284	3
Validation Date	288	9
Sequence Id (RFEDS ID)	298	10
Secondary Result Type	309	3
Matrix	313	8
Lab Disposition	322	15

J	<b>organics:</b> MS data indicate presence of compound but below detection limit (estimated value)	yes	yes
/delete?	<b>inorganics:</b> value greater than IDL but control sample analysis not within control limits (estimated value)	yes	yes
L	undefined	no	no
N	<b>organics:</b> compound presumed present (TIC)	yes, but remove to TIC table	no
N	<b>inorganics:</b> spiked sample recovery not within control limits (estimated value)	yes	yes
N*	<b>inorganics:</b> spiked sample recovery and duplicate analysis not within control limits (estimated value)	yes	yes
R	validation code for rejected data accidentally entered in lab qualifier field (unusable data)	no	no
S	<b>inorganics:</b> the reported value determined by the method of standard additions	yes	yes
U	<b>organics and inorganics:</b> analyte analyzed below detection limit	yes	no
JC	<b>organics:</b> pesticide result confirmed but below detection limit	yes	no
UJ	<b>organics:</b> analyte analyzed but below detection limit	yes	no
UN	<b>organics:</b> compound presumed present but below detection limit	yes	no
UN	<b>inorganics:</b> spiked sample recovery not within control limits and sample result below detection limit	yes	no
UW	<b>inorganics:</b> post-digestion spike for GFAA analysis is out of control limits and sample result is below detection limit	yes	no
UX		yes	no
V	validation code for valid data accidentally entered into lab-qualifier field	yes	yes
W	<b>inorganics:</b> post-digestion spike for GFAA analysis is out of control limits while sample absorbance < 50% of spike absorbance	yes	yes
X	<b>organics (pre-1992):</b> lab software flag (combines more than one qualifier, not defined). ** COMMENT: Do not include in analysis unless accompanied by a validated result. **	**	**

X	inorganics (pre-1992): detection limit greater than normal, spike matrix interference	yes	yes
X	other (OU7 RFI/RI samples): result by calculation defined in GRRASP	yes	yes
Y	rads: chemical yield exceeded acceptable limits (estimated value)	yes	yes

Note on the use of X qualifiers: X is defined in the GRRASP as a result determined by calculation, not by direct laboratory analysis. Therefore, for samples analyzed during the period that the GRRASP has been in effect (since January 1992), the results qualified by an X will be treated as estimated values (similar to J). For historic data, when the GRRASP was not used by laboratories, an X qualifier has two definitions. For organics, the X is a flag entered manually by the laboratory, but is not defined in RFEDS. Therefore, organic results qualified by X are not considered usable data, unless a validated result is given. For inorganics, an X qualifier indicates that the detection limit for the analyte is higher than normal due to matrix interference. Inorganics qualified with an X will be treated like a J result. The X qualifier is sometimes also used with other qualifiers (i.e., UX, XJ); in these cases, the meaning of X depends on the analyte and the date of the analysis.

APPENDIX D  
VALIDATION CODES

<u>Code</u>	<u>Definition</u>	<u>Include in Data Analysis?</u>
J	estimated result	yes
A	acceptable result	yes
JA	acceptable result for estimated value	yes
NOTE: (those data qualified with a "U" but having validation code of "JA" are still non-detects)		
R	rejected result	no
V	valid result	yes
Y	not yet validated; validation in progress	yes
Z	validation not required	yes

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**FROM:** Susan Blake/CH2M Hill

**DATE:** February 11, 1994

**SUBJECT:** Statistical Comparison of RFP OU 3 CDH and RFP Soil Samples

**PROJECT:** RME30181.X1.62

#### INTRODUCTION/PURPOSE

This memorandum documents the statistical analysis that was performed to determine if the RFP OU 3 Colorado Department of Health (CDH) soil sample data are significantly different from the Rocky Flats Plant (RFP) soil sample data. The results indicated the two methods are not significantly different and provide the basis for combining the data for further analysis. CDH and RFP data were analyzed and compared for the following radionuclides: Americium-241, plutonium-239/240, uranium 233/234, uranium-235, and uranium-238.

#### APPROACH

The statistical hypothesis tested is that the CDH radionuclides activity levels are equal to the RFP radionuclides activity levels. The CDH and RFP soil data are matched by sample location and therefore are treated as paired data. The null hypothesis is that the median of the population of paired differences is equal to zero. The alternative hypothesis is the median difference is not equal to zero.

If the null hypothesis is not rejected (i.e. the median of the differences is not significantly different from zero), then it is concluded that the median of the CDH data is not significantly different from the median of the RFP data and the data are combined for further analysis. If the null hypothesis is rejected, then it is concluded that the CDH and RFP sampling result medians are statistically significantly different.

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Two types of statistical comparisons for paired data were performed. The paired t-test is a parametric test that assumes the population of the differences in the pairs are normally distributed and compares the mean of the population of paired differences to zero. (In a normal distribution the mean is the same as the median.)

The Wilcoxon signed rank test is a nonparametric test that makes no probability distribution assumptions about the data. This test determines whether the median of the population of paired differences is equal to zero. The test is more efficient than the t-test for detecting differences in the two groups of data when the data are not normally distributed. The Wilcoxon signed rank test is also appropriate for when the population of the paired differences in the data have heavy-tailed distributions and contain outliers (Snedecor and Cochran, 1989).

SAS statistical software PROCEDURE UNIVARIATE was executed on the differences of the CDH and RFP data paired by location. This SAS output (shown in the Appendix) gives results for the paired t-test and the Wilcoxon signed-rank test.

The SAS output includes the mean and standard deviation of the differences for each comparison. These statistics are used to calculate a T-statistic that is used with the degrees of freedom (equal to the number of paired differences minus one) to determine the probability (known as the p-value) of observing the sample results of the two data sets given the null hypothesis that the mean of the differences is zero. The T-statistic, sample size, and p-values ( $Pr > |T|$ ) are also shown in the SAS PROC UNI output.

In the Wilcoxon signed rank test the absolute values of the differences are ranked, the smallest differences being assigned rank 1. The ranks with the negative signs are totalled and the ranks with the positive signs are totalled. The smaller of these totals is the Sgn Rank (S-statistic) shown in the SAS output. The corresponding p-value ( $Pr > |S|$ ) is also shown.

The comparison approach is the same whether using a paired t-test or the Wilcoxon signed rank test. If the p-value is high (i.e., greater than or equal to 0.05 for 95% confidence), we do not reject the null hypothesis and conclude there is no statistically significant difference in the median of the two data sets. If the probability is low (i.e., less than 0.05), we reject the null hypothesis and conclude there is a statistically significant difference in the medians of the two data sets. Statistically significant differences in the medians of the CDH and RFP soil radionuclide activity level data are qualitatively evaluated to determine if the magnitude of the difference is physically or scientifically significant.

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## ANALYSIS/RESULTS

The SAS PROC UNI results for each radionuclide analyzed are shown in the Appendix to this memorandum. The results are for CDH minus RFP values for each sample location. N is the number of paired differences or sample locations. The results of the paired t-tests and Wilcoxon signed rank test are shown in Table 1. The mean, standard deviation, N, and p-values are shown for each comparison.

TABLE 1. SAS RESULTS OF CDH AND RFO PAIRED TESTS

CDH-RFP	Diff Mean	Diff Std Dev	N	t-test P-value	WSR P-value	Diff?
Am-241	0.00033	0.0428	57	0.9536	0.6533	NO
Pu-239 /240	0.03985	0.1852	61	0.0981	0.9781	NO
Ur-233 /234	0.07456	0.2267	60	0.0135	0.0134	YES
Ur-235	0.00342	0.03984	60	0.5087	0.5137	NO
Ur-238	0.07677	0.2447	60	0.0182	0.0151	YES

The t-test and Wilcoxon signed rank test results are consistent. The mean difference is positive for all the radionuclides indicating the CDH values are on the average higher than the RFP values. However, the uranium-233/234 and uranium-238 CDH and RFP comparisons show the only statistically significant differences with 95% confidence (i.e., the p-values are less than 0.05). These two statistically significant differences were evaluated further.

Summary statistics of uranium-233/234 and uranium-238 CDH and RFP methods are shown in Table 2. The difference in the means of the CDH and RFP method for uranium-233/234 is 0.075 pCi/g. The difference in the means of the means of the CDH and RFP methods for uranium-238 methods is 0.077 pCi/g. These differences were determined to not be physically significant. The other descriptive statistics for the CDH and RFP groups for uranium-233/234 and uranium-238 were qualitatively considered to be similar.

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Based on the results of the paired statistical tests and a review of the descriptive statistics, it was determined to be appropriate to combine the CDH and RFP radionuclide soil sample data for further analysis. The data are combined by averaging the CDH and RFP values at each soil sample location.

TABLE 2. DESCRIPTIVE STATISTICS FOR CDH AND RFP UR-233/234 AND UR-238 SOIL SAMPLE DATA

STATISTIC	UR-233/234 CDH	UR-233/234 RFP	UR-238 CDH	UR-238 RFP
Sample size	60	60	60	60
Mean (pCi/g)	1.051	0.976	1.077	1.000
SD (pCi/g)	0.271	0.289	0.292	0.263
Min (pCi/g)	0.633	0.32	0.39	0.59
Med (pCi/g)	0.997	0.94	1.011	0.948
Max (pCi/g)	1.889	2.39	2.081	2.182

----- REPNAMEC=AMERICIUM-241 -----

Univariate Procedure

Variable=DIFF

=CDM-RFP

Moments

N	57	Sum Wgts	57
Mean	0.000332	Sum	0.0189
Std Dev	0.042788	Variance	0.001831
Skewness	0.1072	Kurtosis	11.03164
USS	0.10253	CSS	0.102524
CV	12904.22	Std Mean	0.005667
T:Mean=0	0.058507	Pr> T	0.9536
Num ^= 0	52	Num > 0	27
M(Sign)	1	Pr>= M	0.8899
Sgn Rank	50	Pr>= S	0.6533

Quantiles (Def=5)

100% Max	0.18	99%	0.18
75% Q3	0.006	95%	0.0297
50% Med	0	90%	0.0239
25% Q1	-0.005	10%	-0.018
0% Min	-0.1703	5%	-0.059
		1%	-0.1703
Range	0.3503		
Q3-Q1	0.011		
Mode	0		

Extremes

Lowest	Obs	Highest	Obs
-0.1703 (	54)	0.025 (	10)
-0.127 (	55)	0.0271 (	53)
-0.059 (	34)	0.0297 (	42)
-0.021 (	56)	0.123 (	48)
-0.021 (	44)	0.18 (	13)

----- REPNAMEC=PLUTONIUM-239/240 -----

## Univariate Procedure

Variable=DIFF

## Moments

N	61	Sum Wgts	61
Mean	0.039848	Sum	2.4307
Std Dev	0.185206	Variance	0.034301
Skewness	3.659651	Kurtosis	15.00187
USS	2.154938	CSS	2.058081
CV	464.7871	Std Mean	0.023713
T:Mean=0	1.680393	Pr> T	0.0981
Num ^= 0	57	Num > 0	28
M(Sign)	-0.5	Pr>= M	1.0000
Sgn Rank	-3.5	Pr>= S	0.9781

## Quantiles (Def=5)

100% Max	0.91	99%	0.91
75% Q3	0.019	95%	0.3
50% Med	0	90%	0.16
25% Q1	-0.0178	10%	-0.048
0% Min	-0.234	5%	-0.0741
		1%	-0.234
Range	1.144		
Q3-Q1	0.0368		
Mode	0		

## Extremes

Lowest	Obs	Highest	Obs
-0.234(	57)	0.22(	60)
-0.147(	59)	0.3(	15)
-0.0871(	25)	0.436(	32)
-0.0741(	44)	0.9(	14)
-0.07(	26)	0.91(	24)

----- REPNAMEC=URANIUM-233/234 -----

Univariate Procedure

Variable=DIFF

Moments

N	60	Sum Wgts	60
Mean	0.074562	Sum	4.4737
Std Dev	0.226697	Variance	0.051391
Skewness	-0.27565	Kurtosis	-0.37912
USS	3.365658	CSS	3.032092
CV	304.0392	Std Mean	0.029266
T:Mean=0	2.547687	Pr> T	0.0135
Num ^= 0	58	Num > 0	38
M(Sign)	9	Pr>= M	0.0247
Sgn Rank	315	Pr>= S	0.0134

Quantiles (Def=5)

100% Max	0.5	99%	0.5
75% Q3	0.2365	95%	0.41
50% Med	0.09	90%	0.38
25% Q1	-0.085	10%	-0.2015
0% Min	-0.501	5%	-0.31
		1%	-0.501
Range	1.001		
Q3-Q1	0.3215		
Mode	0.09		

Extremes

Lowest	Obs	Highest	Obs
-0.501(	48)	0.4(	14)
-0.4(	46)	0.4(	18)
-0.37(	16)	0.42(	35)
-0.25(	21)	0.45(	1)
-0.23(	53)	0.5(	50)

----- REPNAMEC=URANIUM-235 -----

Univariate Procedure

Variable=DIFF

Moments

N	60	Sum Wgts	60
Mean	0.00342	Sum	0.2052
Std Dev	0.039842	Variance	0.001587
Skewness	-0.02913	Kurtosis	3.619726
USS	0.094356	CSS	0.093655
CV	1164.964	Std Mean	0.005144
T:Mean=0	0.664911	Pr> T	0.5087
Num ^= 0	56	Num > 0	29
M(Sign)	1	Pr>= M	0.8939
Sgn Rank	81	Pr>= S	0.5137

Quantiles (Def=5)

100% Max	0.128	99%	0.128
75% Q3	0.021	95%	0.0785
50% Med	0	90%	0.0444
25% Q1	-0.01225	10%	-0.04
0% Min	-0.143	5%	-0.0501
		1%	-0.143
Range	0.271		
Q3-Q1	0.03325		
Mode	0		

Extremes

Lowest	Obs	Highest	Obs
-0.143 (	44)	0.057 (	6)
-0.053 (	13)	0.064 (	28)
-0.051 (	10)	0.093 (	49)
-0.0492 (	43)	0.093 (	8)
-0.048 (	34)	0.128 (	29)

----- REPNAMEC=URANIUM-238 -----

Univariate Procedure

Variable=DIFF

Moments

N	60	Sum Wgts	60
Mean	0.076765	Sum	4.6059
Std Dev	0.244698	Variance	0.059877
Skewness	0.775055	Kurtosis	3.110143
USS	3.886322	CSS	3.53275
CV	318.7625	Std Mean	0.03159
T:Mean=0	2.430012	Pr> T	0.0182
Num ^ = 0	55	Num > 0	36
M(Sign)	8.5	Pr>= M	0.0300
Sgn Rank	286	Pr>= S	0.0151

Quantiles (Def=5)

100% Max	1.01	99%	1.01
75% Q3	0.20045	95%	0.45
50% Med	0.0794	90%	0.344
25% Q1	-0.0835	10%	-0.19
0% Min	-0.56	5%	-0.28
		1%	-0.56
Range	1.57		
Q3-Q1	0.28395		
Mode	0		

Extremes

Lowest	Obs	Highest	Obs
-0.56 (	35)	0.37 (	2)
-0.35 (	26)	0.44 (	34)
-0.3 (	46)	0.46 (	13)
-0.26 (	47)	0.65 (	59)
-0.2 (	19)	1.01 (	50)

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## APPENDIX B. BACKGROUND COMPARISON RESULTS – SAS OUTPUT FOR SURFACE SOILS

Statistical Application Software (SAS) (SAS Institute, Inc., SAS Language: Reference, Version 6, First Edition, Cary, NC) was used to perform the statistical analysis and generate graphics. The series of statistical tests was performed as appropriate for each comparison of OU 3 surface soil data to background data. As noted in Section 3.0, the statistical tests were performed for surface soil only and results are summarized in the attached tables. The UTL (hot-measurement), slippage, and Gehan tests were applied to all comparisons. The quantile and t-test were performed as appropriate (Gilbert, 1993).

Table B-1 shows summary statistics and distribution test results for the surface soil parameters analyzed. The nondetect rates for background and site data are shown in the column "NONDETECT RATE." The nondetect rates of the background and site data combined are shown in the column "NONDETECT RATE COMBINED." These detect rates are used to select the appropriate statistical comparison tests to apply to the data.

The last two columns in Table B-1 ("NORMAL P-VALUE" and "LOGNORM P-VALUE") are the results of the Shapiro-Wilk test for normality and lognormality, respectively, of the data. Lognormality is tested by applying the procedure to the natural logarithm of the data. The Shapiro-Wilk procedure produces a test statistic for the null hypothesis that the input data values are a random sample from a normal distribution. To determine whether to reject the null hypothesis of normality, the probability, or "p-value," associated with the statistic is examined. For 95 percent confidence, if this probability is less than 0.05, then the null hypothesis is rejected, and one can conclude the data do not come from a normal distribution. For example, in Table B-1, <sup>241</sup>Am background data follow a normal (p-value=0.87872) or lognormal (p-value=0.88258) distribution. However, <sup>241</sup>Am site data do not follow a normal or lognormal distribution (p-values<0.00000). The distribution of the data is another criterion that is used in selecting the appropriate statistical test to apply to the data.

Table B-1. OU 3 Plus Jeffco Surface Soil Data

OBS	PARAMETER	AREA	N	NONDETECT		NONDETECT		LOGNORM
				RATE	RATE	P-VALUE	P-VALUE	
1	AMERICICIUM-241	B	16	0.062500	0.064220	0.87872	0.88258	
2	AMERICICIUM-241	S	93	0.064516	0.064220	0.00000	0.00000	
3	PLUTONIUM-239/240	B	20	0.000000	0.000000	0.14914	0.15906	
4	PLUTONIUM-239/240	S	109	0.000000	0.000000	0.00000	0.00000	
5	URANIUM-233/234	B	15	0.000000	0.000000	0.05478	0.06462	
6	URANIUM-233/234	S	60	0.000000	0.000000	0.00007	0.00012	
7	URANIUM-235	B	15	0.066667	0.053333	0.00002	0.00349	
8	URANIUM-235	S	60	0.050000	0.053333	0.05478	0.06462	
9	URANIUM-238	B	15	0.000000	0.000000	0.00007	0.00012	
10	URANIUM-238	S	60	0.000000	0.000000	0.77575	0.76366	

OBS	MEAN	STD DEV	MINIMUM	MAXIMUM	MEDIAN	NORMAL		LOGNORM
						P-VALUE	P-VALUE	
1	0.01885	0.01080	-0.0030	0.0405	0.01950	0.87872	0.88258	
2	0.07653	0.09189	-0.0020	0.5200	0.03770	0.00000	0.00000	
3	0.05356	0.02050	0.0260	0.1000	0.04875	0.14914	0.15906	
4	0.53362	0.85558	0.0075	6.4680	0.22520	0.00000	0.00000	
5	1.15361	0.15327	0.9219	1.4720	1.20000	0.36733	0.37470	
6	1.01353	0.25610	0.5300	2.1395	0.96000	0.00002	0.00349	
7	0.04773	0.03510	0.0106	0.1393	0.04000	0.05478	0.06462	
8	0.04906	0.02266	0.0125	0.1235	0.04695	0.00007	0.00012	
9	1.19193	0.19308	0.8989	1.5210	1.20000	0.77575	0.76366	
10	1.03832	0.24957	0.6700	2.1315	1.00825	0.00001	0.00119	

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Table B-2 shows the samples that exceed the upper tolerance limit (UTL) for the Hot-Measurement test. Americium<sup>241</sup> has 36 samples exceeding the UTL at 99 percent confidence for the 99th percentile, <sup>239/240</sup>Pu has 62, <sup>233/234</sup>U has one, and <sup>238</sup>U has one. Four of the five parameters analyzed are considered a PCOC by this criterion.

The results of all the statistical tests are shown in Table B-3. The third column shows the number of samples exceeding the UTL. The next two columns in Table B-3 show the maximum value as well as number of samples greater than the calculated slippage value, respectively. The statistical tests columns show the p-values for the slippage, quantile, Gehan, and t-test. If the t-test column has a blank, then the data do not meet the test criteria and the statistical test was not performed. These p-values have the same meaning as the p-value for the Shapiro-Wilk test. If the p-value is less than 0.05, then we reject the null hypothesis of no difference between site and background and conclude that background is different from site with 95 percent confidence. Based on these tests and the UTL, four of the five parameters are identified in the last column of Table B-3 as PCOCs.

Graphics were generated as visual aids for analyzing the data. Normal and lognormal probability plots, box plots, and histograms were generated for OU 3 surface soil and background for each analyte.

The visual graphics for OU 3 surface soils are presented in Figures B-1 to B-10 as follows:

- Figure B-1 – Probability Plots for IHSS 199 Surface Soil Data <sup>241</sup>Am
- Figure B-2 – Box Plots and Histograms for IHSS 199 Surface Soil Data <sup>241</sup>Am
- Figure B-3 – Probability Plots for IHSS 199 Surface Soil Data <sup>239/240</sup>Pu
- Figure B-4 – Box Plots and Histograms for IHSS 199 Surface Soil Data <sup>239/240</sup>Pu
- Figure B-5 – Probability Plots for IHSS 199 Surface Soil Data <sup>233/234</sup>U
- Figure B-6 – Box Plots and Histograms for IHSS 199 Surface Soil Data <sup>233/234</sup>U
- Figure B-7 – Probability Plots for IHSS 199 Surface Soil Data <sup>238</sup>U
- Figure B-8 – Box Plots and Histograms for IHSS 199 Surface Soil Data <sup>238</sup>U

Table B-2. Values Exceeding UTL(99%/99%) for OU 3 Plus Jeffco Surface Soil Data

PARAMETER	RESULTS			VALUE EXCEEDING		SAMPLE LOCATION
	UTL	LOG OF RESULT	UTL	UTL	UTL	
AMERICICIUM-241	PCI/G	0.5200	0.81704	1.00063	1.00063	PT14192
AMERICICIUM-241	PCI/G	0.0805	0.81704	0.82439	0.82439	PT15192
AMERICICIUM-241	PCI/G	0.0953	0.81704	0.83086	0.83086	PT15292
AMERICICIUM-241	PCI/G	0.0675	0.81704	0.81868	0.81868	PT16292
AMERICICIUM-241	PCI/G	0.0985	0.81704	0.83226	0.83226	PT18592
AMERICICIUM-241	PCI/G	0.1659	0.81704	0.86116	0.86116	PT19292
AMERICICIUM-241	PCI/G	0.0765	0.81704	0.82264	0.82264	PT19492
AMERICICIUM-241	PCI/G	0.0647	0.81704	0.81744	0.81744	T11
AMERICICIUM-241	PCI/G	0.1997	0.81704	0.87534	0.87534	T13A
AMERICICIUM-241	PCI/G	0.0951	0.81704	0.83078	0.83078	T13B
AMERICICIUM-241	PCI/G	0.1000	0.81704	0.83291	0.83291	T14A
AMERICICIUM-241	PCI/G	0.0882	0.81704	0.82777	0.82777	T14B
AMERICICIUM-241	PCI/G	0.2128	0.81704	0.88079	0.88079	T15A
AMERICICIUM-241	PCI/G	0.1403	0.81704	0.85028	0.85028	T15B
AMERICICIUM-241	PCI/G	0.1614	0.81704	0.85925	0.85925	T4A
AMERICICIUM-241	PCI/G	0.0784	0.81704	0.82347	0.82347	T4B
AMERICICIUM-241	PCI/G	0.1277	0.81704	0.84488	0.84488	T5
AMERICICIUM-241	PCI/G	0.1137	0.81704	0.83885	0.83885	T9
AMERICICIUM-241	PCI/G	0.3631	0.81704	0.94122	0.94122	U10A
AMERICICIUM-241	PCI/G	0.2291	0.81704	0.88752	0.88752	U10B
AMERICICIUM-241	PCI/G	0.1119	0.81704	0.83807	0.83807	U11A
AMERICICIUM-241	PCI/G	0.1406	0.81704	0.85041	0.85041	U11B
AMERICICIUM-241	PCI/G	0.1948	0.81704	0.87330	0.87330	U12A
AMERICICIUM-241	PCI/G	0.1222	0.81704	0.84252	0.84252	U12B
AMERICICIUM-241	PCI/G	0.1965	0.81704	0.87401	0.87401	U13A
AMERICICIUM-241	PCI/G	0.1585	0.81704	0.85803	0.85803	U13B
AMERICICIUM-241	PCI/G	0.1379	0.81704	0.84925	0.84925	U14A
AMERICICIUM-241	PCI/G	0.1613	0.81704	0.85921	0.85921	U14B
AMERICICIUM-241	PCI/G	0.2792	0.81704	0.90794	0.90794	U3A
AMERICICIUM-241	PCI/G	0.2602	0.81704	0.90024	0.90024	U3B
AMERICICIUM-241	PCI/G	0.0990	0.81704	0.83247	0.83247	U4
AMERICICIUM-241	PCI/G	0.1176	0.81704	0.84053	0.84053	U5

Table B-2. Values Exceeding UTL(99%/99%) for OU 3 Plus Jeffco Surface Soil Data

PARAMETER	UTL	RESULTS	LOG OF RESULT	VALUE EXCEEDING UTL	SAMPLE LOCATION
AMERICICIUM-241	0.81704	0.1008	0.83326	0.83326	U6
AMERICICIUM-241	0.81704	0.2677	0.90329	0.90329	U7
AMERICICIUM-241	0.81704	0.1500	0.85442	0.85442	U8
AMERICICIUM-241	0.81704	0.3059	0.91865	0.91865	U9
PLUTONIUM-239/240	0.84723	0.2050	0.87755	0.87755	PT13592
PLUTONIUM-239/240	0.84723	2.9500	1.63900	1.63900	PT14192
PLUTONIUM-239/240	0.84723	0.2800	0.90826	0.90826	PT14292
PLUTONIUM-239/240	0.84723	0.2700	0.90422	0.90422	PT14392
PLUTONIUM-239/240	0.84723	0.1604	0.85883	0.85883	PT15092
PLUTONIUM-239/240	0.84723	0.7450	1.08011	1.08011	PT15192
PLUTONIUM-239/240	0.84723	0.5107	0.99721	0.99721	PT15292
PLUTONIUM-239/240	0.84723	0.2150	0.88170	0.88170	PT15392
PLUTONIUM-239/240	0.84723	0.2820	0.90906	0.90906	PT15992
PLUTONIUM-239/240	0.84723	0.6650	1.05257	1.05257	PT18592
PLUTONIUM-239/240	0.84723	0.7350	1.07671	1.07671	PT18692
PLUTONIUM-239/240	0.84723	0.1480	0.85356	0.85356	PT19192
PLUTONIUM-239/240	0.84723	0.3210	0.92466	0.92466	PT19292
PLUTONIUM-239/240	0.84723	0.2500	0.89609	0.89609	PT19592
PLUTONIUM-239/240	0.84723	0.2487	0.89556	0.89556	T10
PLUTONIUM-239/240	0.84723	0.4803	0.98593	0.98593	T11
PLUTONIUM-239/240	0.84723	0.2883	0.91160	0.91160	T12A
PLUTONIUM-239/240	0.84723	0.3564	0.93860	0.93860	T12B
PLUTONIUM-239/240	0.84723	0.8913	1.12859	1.12859	T13A
PLUTONIUM-239/240	0.84723	0.6856	1.05973	1.05973	T13B
PLUTONIUM-239/240	0.84723	0.6077	1.03237	1.03237	T14A
PLUTONIUM-239/240	0.84723	0.4324	0.96790	0.96790	T14B
PLUTONIUM-239/240	0.84723	1.3360	1.26300	1.26300	T15A
PLUTONIUM-239/240	0.84723	1.0840	1.18906	1.18906	T15B
PLUTONIUM-239/240	0.84723	0.3322	0.92909	0.92909	T15B
PLUTONIUM-239/240	0.84723	0.9517	1.14794	1.14794	T1A
PLUTONIUM-239/240	0.84723	1.4750	1.30155	1.30155	T1B
PLUTONIUM-239/240	0.84723	0.7572	1.08424	1.08424	T2A

Table B-2. Values Exceeding UTL(99%/99%) for OU 3 Plus Jeffco Surface Soil Data

PARAMETER	UTL	RESULTS	LOG OF RESULT	VALUE EXCEEDING UTL	SAMPLE LOCATION
PLUTONIUM-239/240	0.84723	0.6805	1.05796	1.05796	T2B
PLUTONIUM-239/240	0.84723	1.6000	1.33500	1.33500	T2C
PLUTONIUM-239/240	0.84723	0.9228	1.13873	1.13873	T3A
PLUTONIUM-239/240	0.84723	0.7336	1.07623	1.07623	T3B
PLUTONIUM-239/240	0.84723	0.6555	1.04925	1.04925	T3C
PLUTONIUM-239/240	0.84723	0.8084	1.10141	1.10141	T4A
PLUTONIUM-239/240	0.84723	0.3650	0.94196	0.94196	T4B
PLUTONIUM-239/240	0.84723	0.5661	1.01744	1.01744	T5
PLUTONIUM-239/240	0.84723	0.4764	0.98447	0.98447	T6
PLUTONIUM-239/240	0.84723	0.1624	0.85968	0.85968	T7
PLUTONIUM-239/240	0.84723	0.2252	0.88591	0.88591	T8
PLUTONIUM-239/240	0.84723	0.5915	1.02658	1.02658	T9
PLUTONIUM-239/240	0.84723	1.7390	1.37093	1.37093	U10A
PLUTONIUM-239/240	0.84723	1.0890	1.19058	1.19058	U10B
PLUTONIUM-239/240	0.84723	0.7180	1.07090	1.07090	U11A
PLUTONIUM-239/240	0.84723	0.7711	1.08893	1.08893	U11B
PLUTONIUM-239/240	0.84723	0.9722	1.15443	1.15443	U12A
PLUTONIUM-239/240	0.84723	0.7422	1.07916	1.07916	U12B
PLUTONIUM-239/240	0.84723	1.2720	1.24473	1.24473	U13A
PLUTONIUM-239/240	0.84723	0.7617	1.08576	1.08576	U13B
PLUTONIUM-239/240	0.84723	0.6831	1.05887	1.05887	U14A
PLUTONIUM-239/240	0.84723	0.9893	1.15980	1.15980	U14B
PLUTONIUM-239/240	0.84723	6.4680	2.15964	2.15964	U1A
PLUTONIUM-239/240	0.84723	2.6720	1.58350	1.58350	U1B
PLUTONIUM-239/240	0.84723	3.5900	1.75613	1.75613	U2A
PLUTONIUM-239/240	0.84723	1.2190	1.22935	1.22935	U2B
PLUTONIUM-239/240	0.84723	1.6960	1.35995	1.35995	U3A
PLUTONIUM-239/240	0.84723	1.1900	1.22083	1.22083	U3B
PLUTONIUM-239/240	0.84723	0.1777	0.86613	0.86613	U4
PLUTONIUM-239/240	0.84723	0.4119	0.96008	0.96008	U5
PLUTONIUM-239/240	0.84723	0.4236	0.96455	0.96455	U6
PLUTONIUM-239/240	0.84723	5.510	1.20926	1.20926	U7

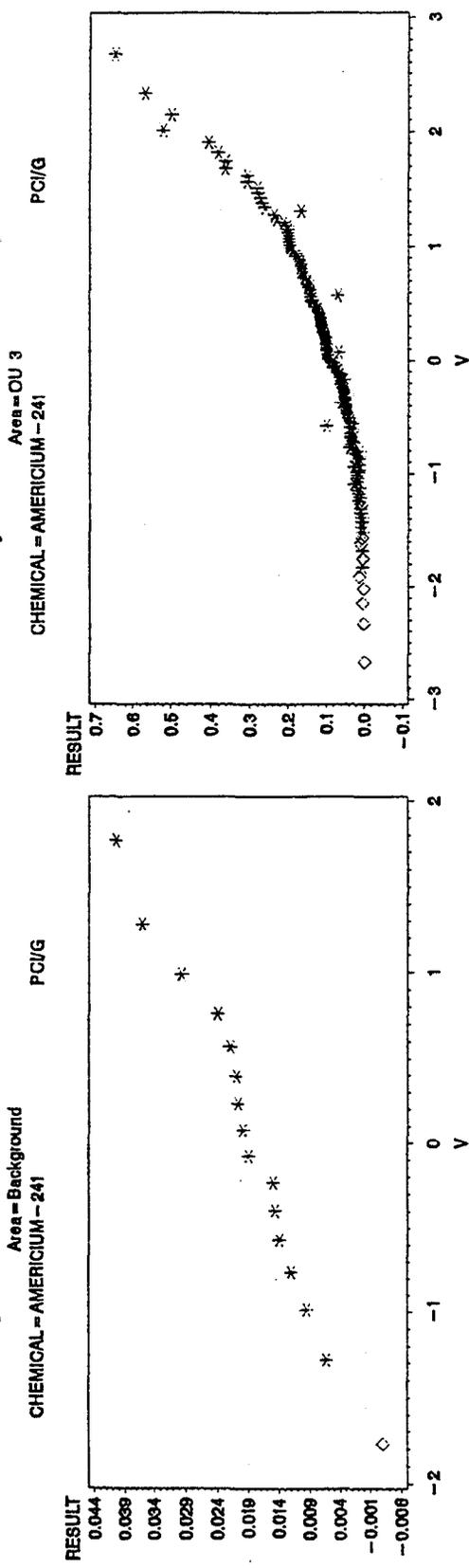
Table B-2. Values Exceeding UTL(99%/99%) for OU 3 Plus Jeffco Surface Soil Data

PARAMETER	UTL	RESULTS	LOG OF RESULT	VALUE EXCEEDING		SAMPLE LOCATION
				UTL	UTL	
PLUTONIUM-239/240	0.84723	0.2009	0.87584	0.87584	U8	
PLUTONIUM-239/240	0.84723	1.8570	1.40044	1.40044	U9	
URANIUM-233/234	1.40153	2.1395	1.46776	1.46776	PT17992	
URANIUM-238	2.00717	2.1315	1.46591	2.13150	PT17992	

Table B-3. Test Results for OU 3 Plus Jeffco Surface Soil Data

PARAMETER	NO.		MAXIMUM	NO.		SLIPPAG		QUANTIL		GEHAN		T-TEST	
	SAMP	>UTL		SAMP	>SLIP	P-VALUE	P-VALUE						
AMERICIUM-241	36		0.0405	46		0.00006		0.01986		0.01125			
PLUTONIUM-239/240	62		0.1000	64		0.00000		0.00729		0.00273		.0000000026460	Yes
URANIUM-233/234	1		1.4720	3		0.50678		0.98189		0.99897			Yes
URANIUM-235	.		.	.		1.00000		0.85982		0.20954			no
URANIUM-238	1		1.5210	2		0.63784		0.99157		0.99670			Yes

### Normal Probability Plots of OU 3 Plus Jeffco SS Data



### Log - normal Probability Plots of OU3 Plus Jeffco SS DataLog - normal Probability Plots of OU3 Plus Jeffco SS Data

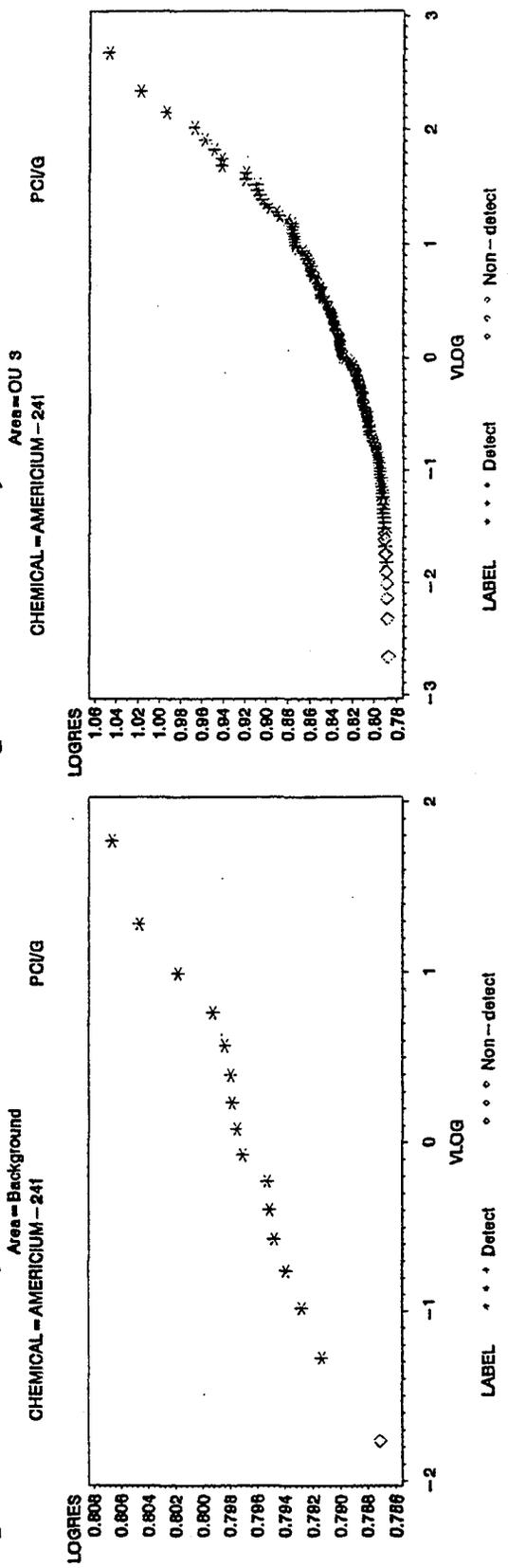


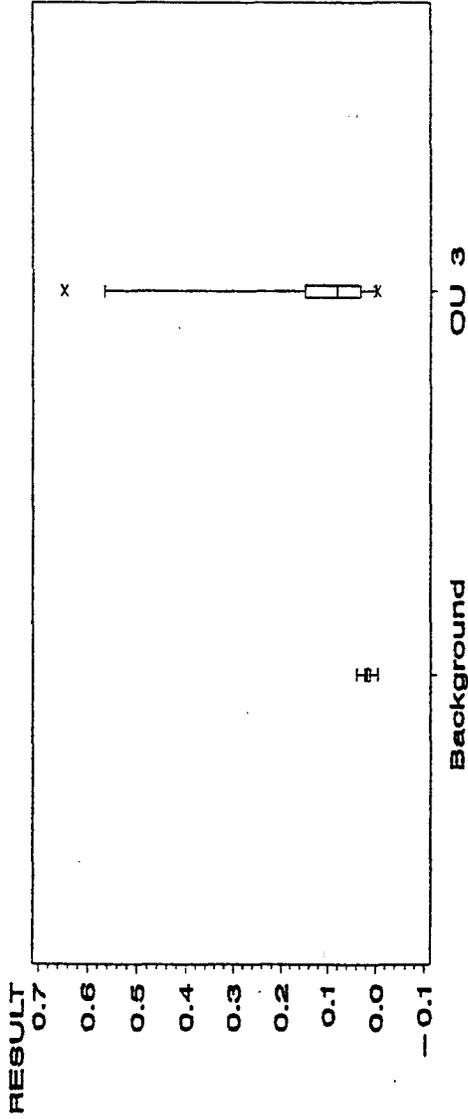
Figure B-1 - Probability Plots for IHSS 199 Surface Soil Data 241Am

(This figure is a draft version; it will be revised for the next draft of TM 4.)

# Box Plots and Histograms of OU 3 Plus Jeffco SS Data

CHEMICAL - AMERICIUM - 241

PCI/G



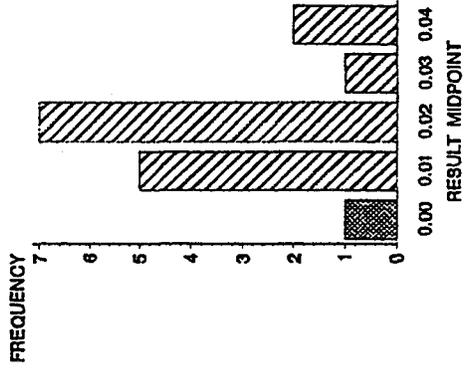
Background

OU 3

Area = Background

CHEMICAL - AMERICIUM - 241

PCI/G

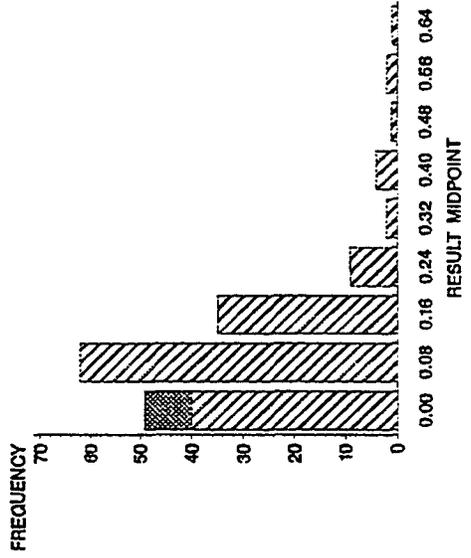


LABEL Detect Non-detect

Area = OU 3

CHEMICAL - AMERICIUM - 241

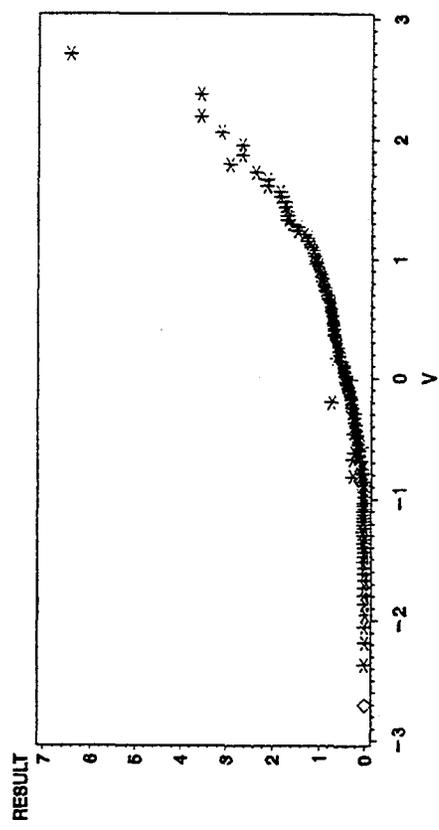
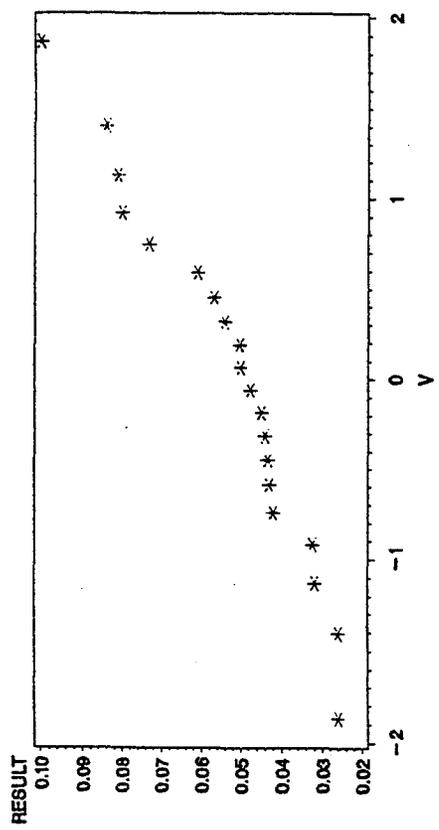
PCI/G



LABEL Detect Non-detect

Normal Probability Plots of OU 3 Plus Jeffco SS Data

Area = Background  
 CHEMICAL = PLUTONIUM - 239/240  
 PC/G



Log - normal Probability Plots of OU3 Plus Jeffco SS DataLog - normal Probability Plots of OU3 Plus Jeffco SS Data

Area = Background  
 CHEMICAL = PLUTONIUM - 239/240  
 PC/G

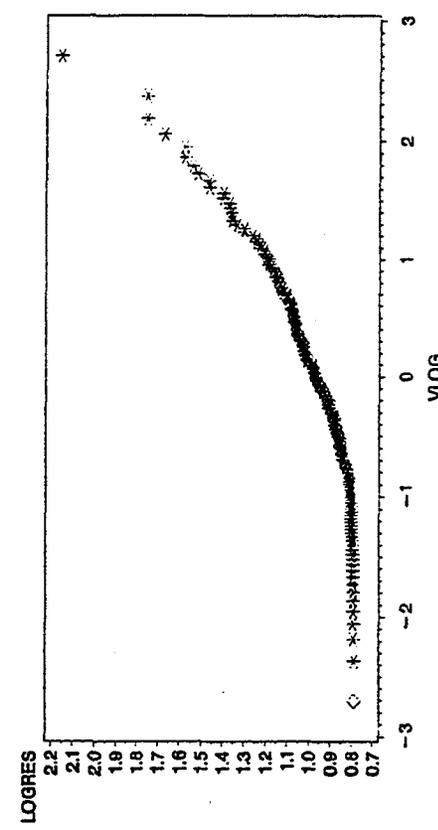
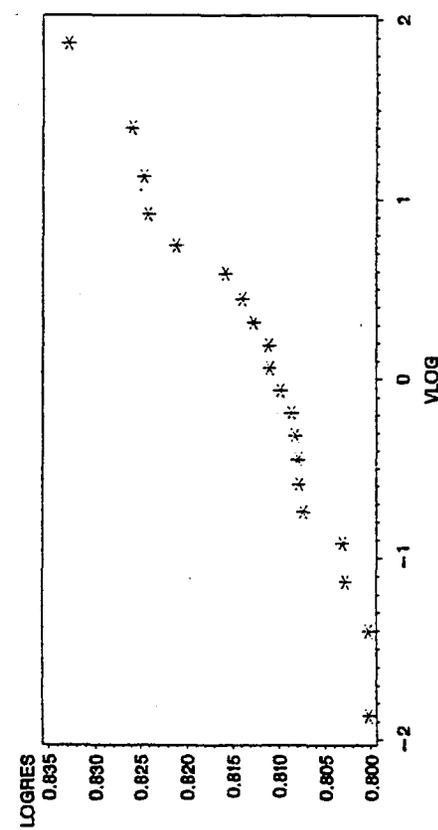
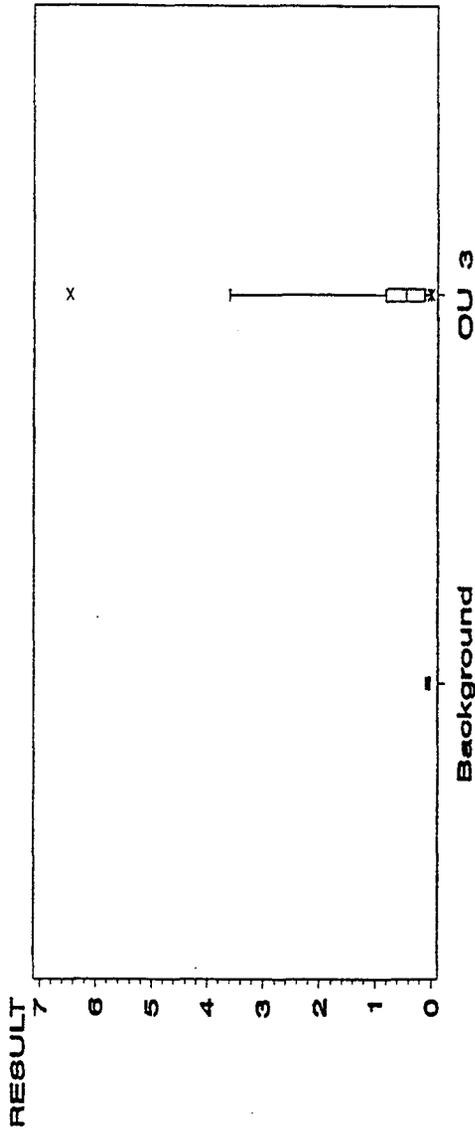


Figure B-3 - Probability Plots for IHSS 199 Surface Soil Data 239/240Pu

(This figure is a draft version; it will be revised for the next draft of TM 4.)

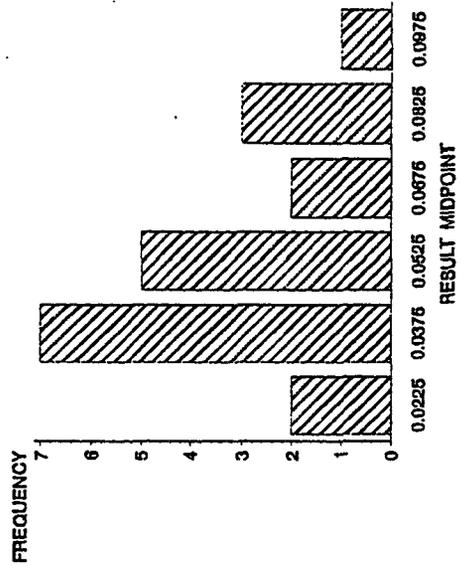
# Box Plots and Histograms of OU 3 Plus Jeffco SS Data

CHEMICAL - PLUTONIUM - 239/240 PCI/G



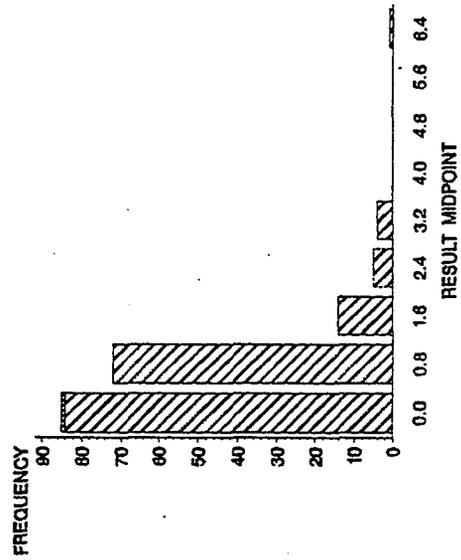
Area = Background

CHEMICAL - PLUTONIUM - 239/240 PCI/G



Area = OU 3

CHEMICAL - PLUTONIUM - 239/240 PCI/G

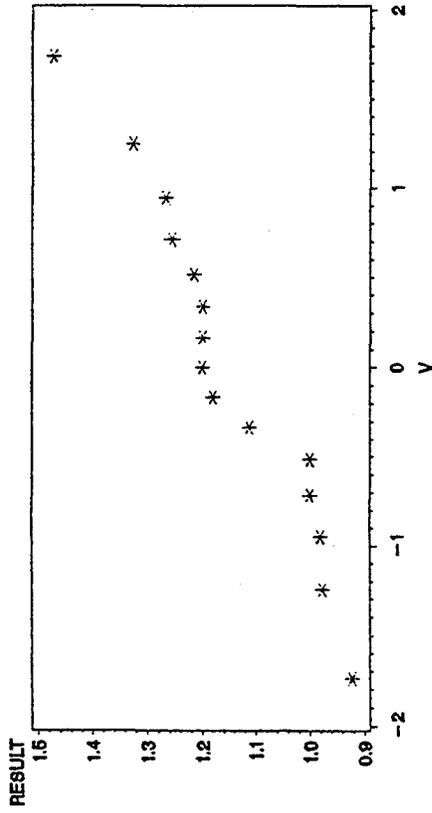


LABEL Defect Non - defect

Figure B-4 - Box Plots and Histograms for IHSS 199 Surface Soil Data (239/240Pu). This figure is a draft version; it will be revised for the next draft of TM 4.

Normal Probability Plots of OU 3 Plus Jeffco SS Data

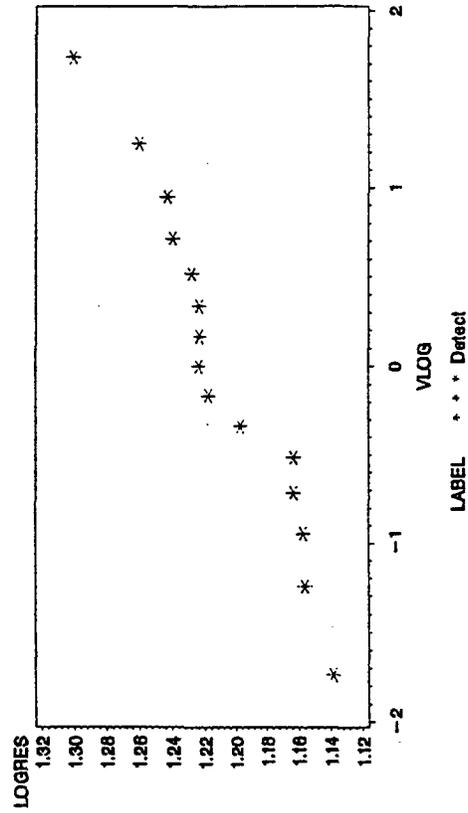
Area = Background  
 CHEMICAL = URANIUM - 233/234  
 PC/G



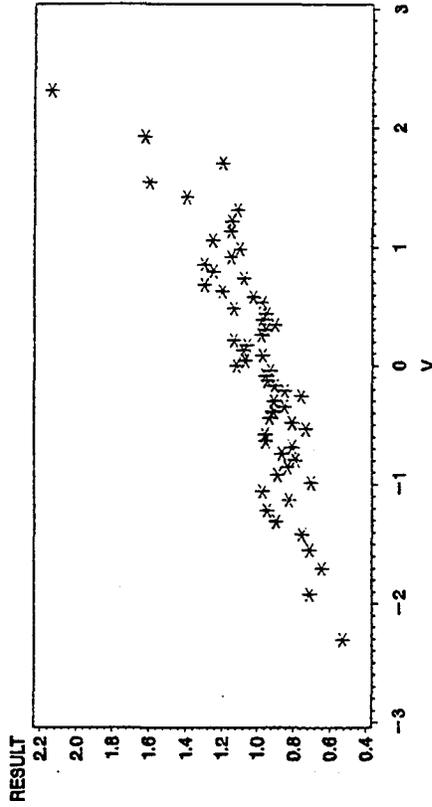
LABEL \* \* \* Defect

Log - normal Probability Plots of OU3 Plus Jeffco SS DataLog - normal Probability Plots of OU3 Plus Jeffco SS Data

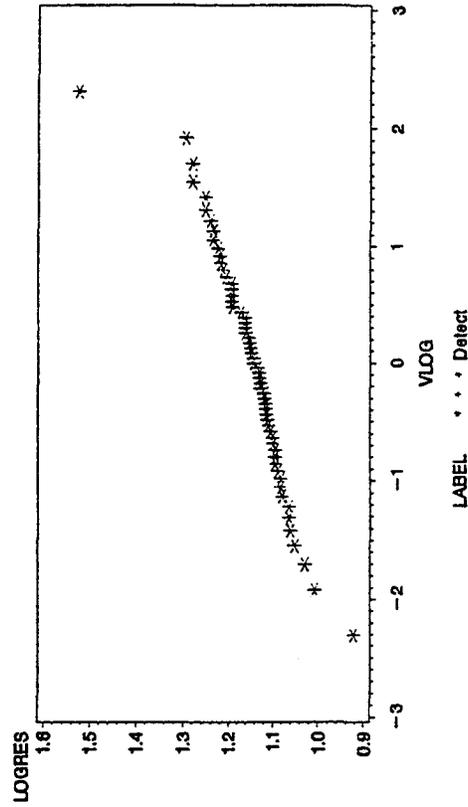
Area = Background  
 CHEMICAL = URANIUM - 233/234  
 PC/G



LABEL \* \* \* Defect



LABEL \* \* \* Defect



LABEL \* \* \* Defect

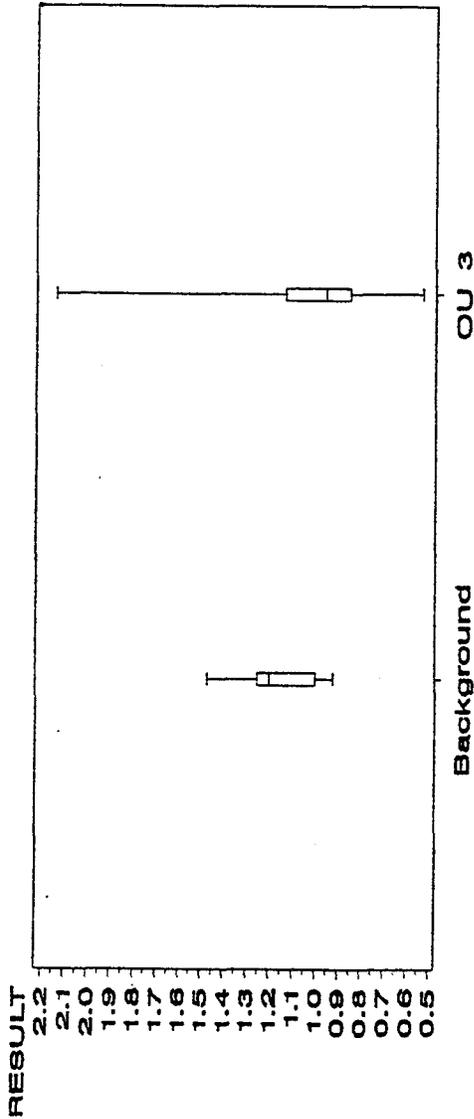
Figure B-5 - Probability Plots for IHSS 199 Surface Soil Data 233/234U

(This figure is a draft version; it will be revised for the next draft of TM 4.)

# Box Plots and Histograms of OU 3 Plus Jeffco SS Data

CHEMICAL = URANIUM - 233/234

PCI/G



Background

OU 3

Area = Background

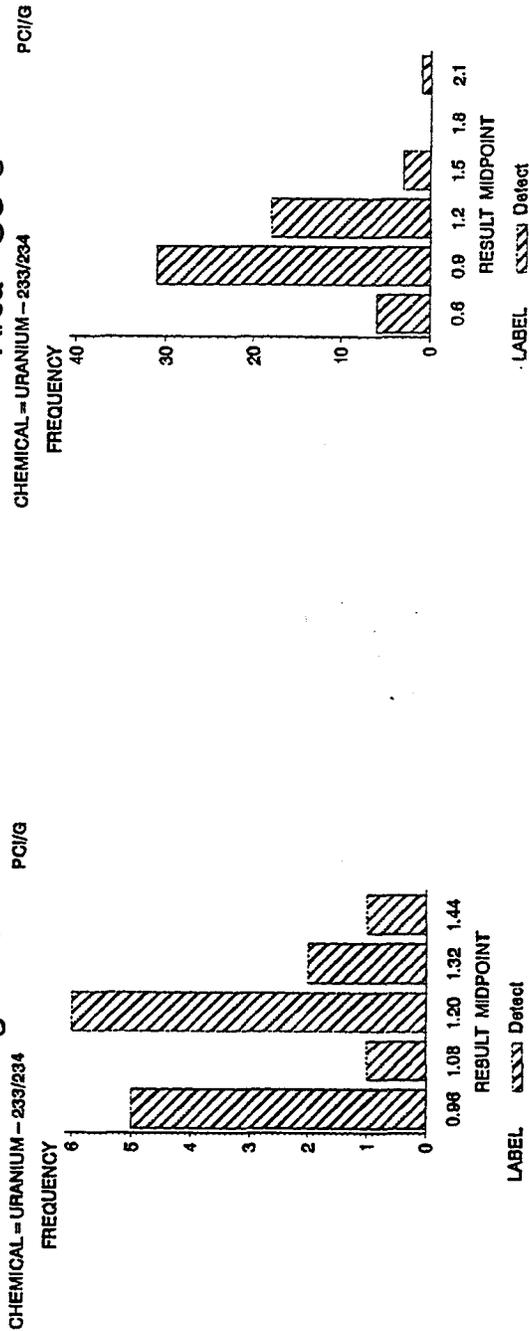
CHEMICAL = URANIUM - 233/234

PCI/G

Area = OU 3

CHEMICAL = URANIUM - 233/234

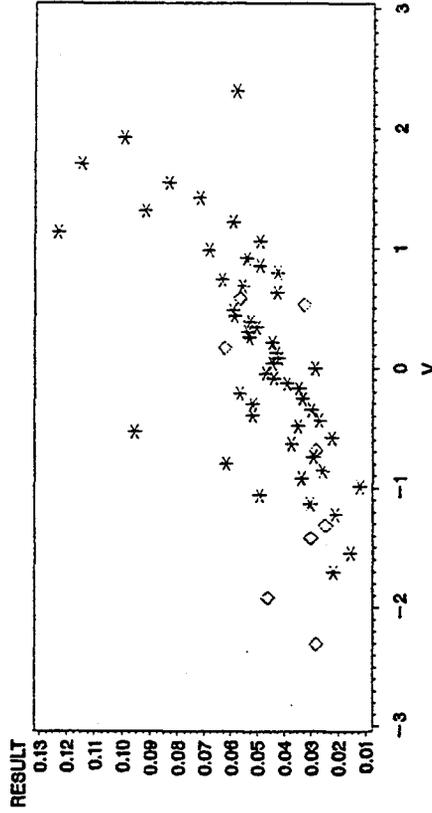
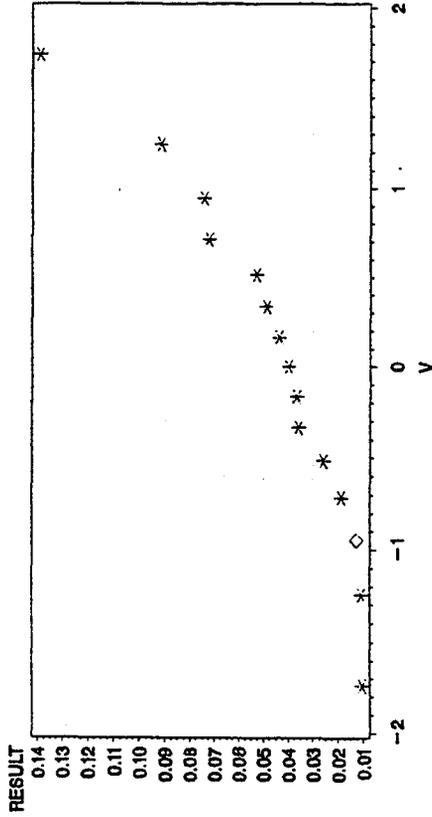
PCI/G



**Figure 6 - Box Plots and Histograms for IHSS 199 Surface Soil Data**  
 (This is a draft version; it will be revised for the next draft of TM 4.)

### Normal Probability Plots of OU 3 Plus Jeffco SS Data

Area = Background  
 CHEMICAL = URANIUM - 235  
 PC/G

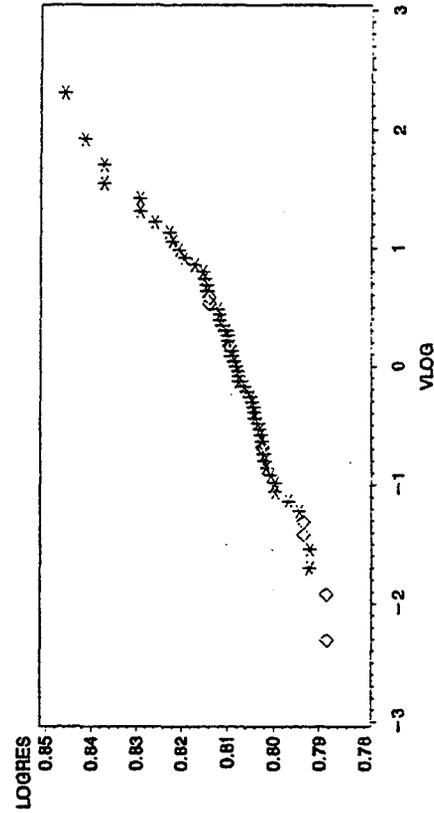
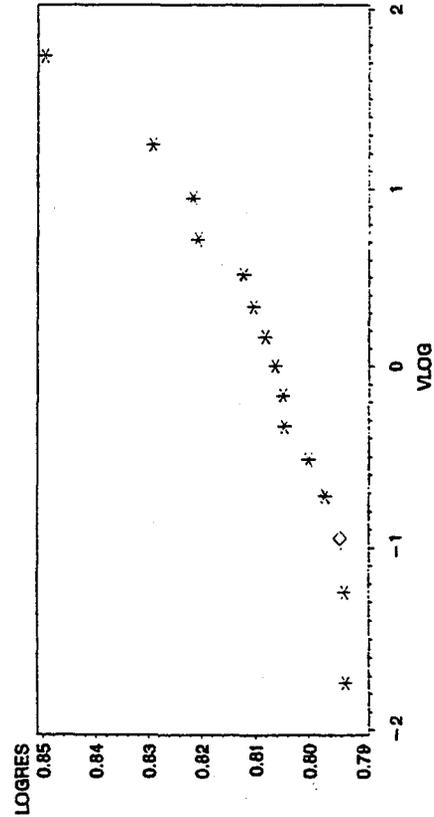


LABEL \* \* \* Detect    ◊ ◊ ◊ Non-detect

LABEL \* \* \* Detect    ◊ ◊ ◊ Non-detect

### Log-normal Probability Plots of OU 3 Plus Jeffco SS Data

Area = Background  
 CHEMICAL = URANIUM - 235  
 PC/G



LABEL \* \* \* Detect    ◊ ◊ ◊ Non-detect

LABEL \* \* \* Detect    ◊ ◊ ◊ Non-detect

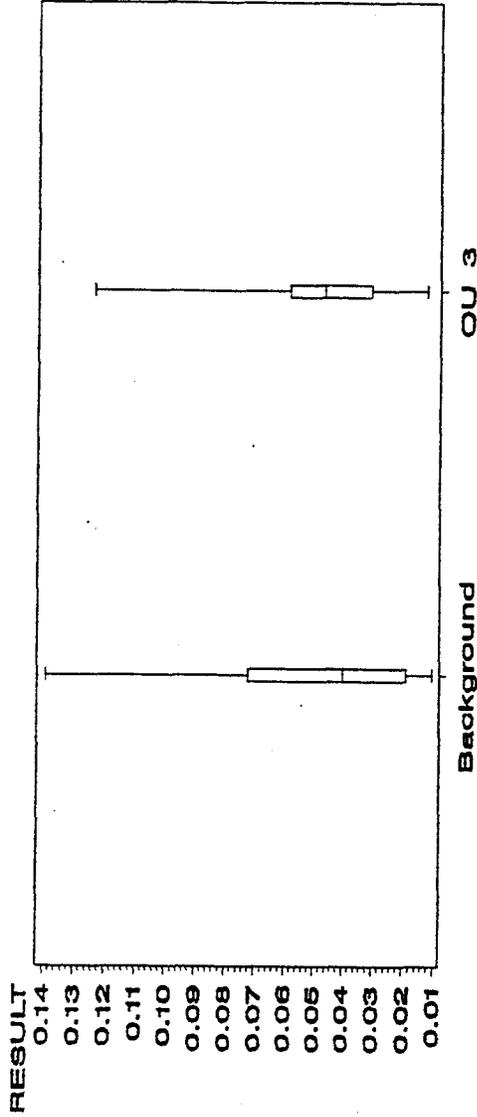
Figure B-7 - Probability Plots for IHSS 199 Surface Soil Data 235U

(This figure is a draft version; it will be revised for the next draft of TM 4.)

# Box Plots and Histograms of OU 3 Plus Jeffco SS Data

CHEMICAL = URANIUM - 235

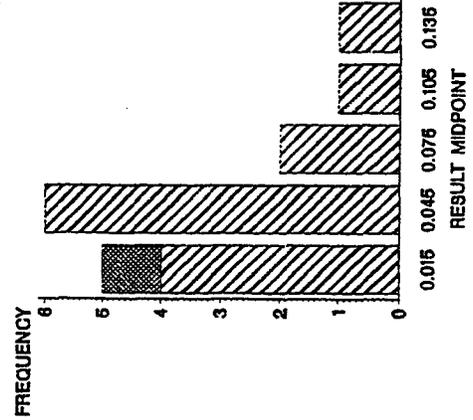
PCI/G



Area = Background

CHEMICAL = URANIUM - 235

PCI/G

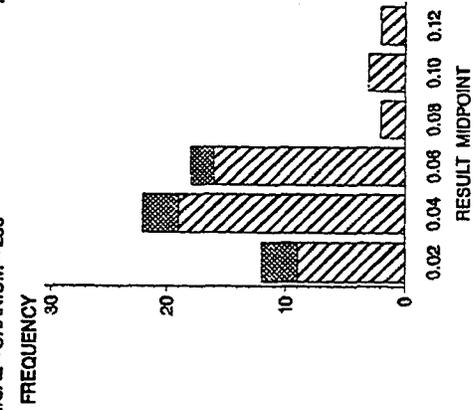


LABEL Defect Non-defect

Area = OU 3

CHEMICAL = URANIUM - 235

PCI/G

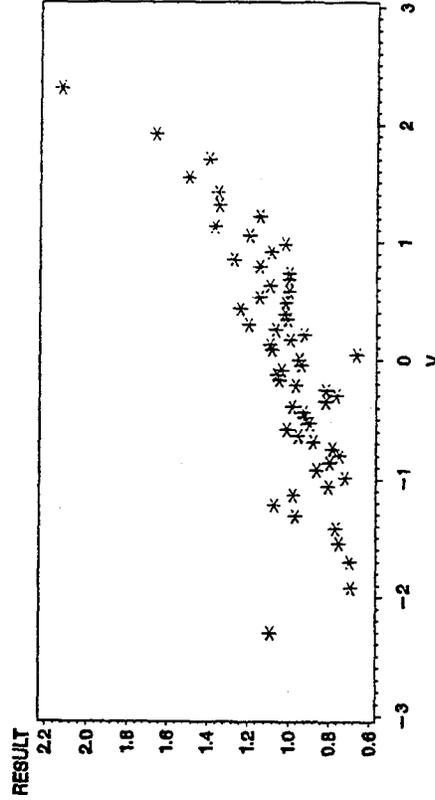
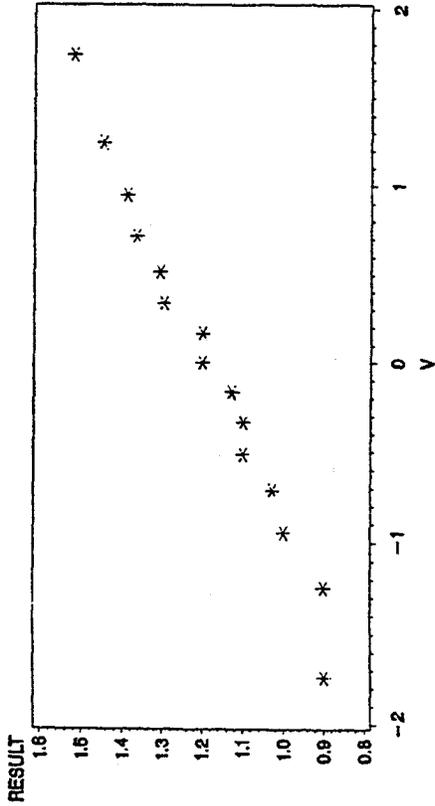


LABEL Defect Non-defect



### Normal Probability Plots of OU 3 Plus Jeffco SS Data

Area = Background  
 CHEMICAL = URANIUM - 238  
 PC/G



### Log - normal Probability Plots of OU3 Plus Jeffco SS DataLog - normal Probability Plots of OU3 Plus Jeffco SS Data

Area = Background  
 CHEMICAL = URANIUM - 238  
 PC/G

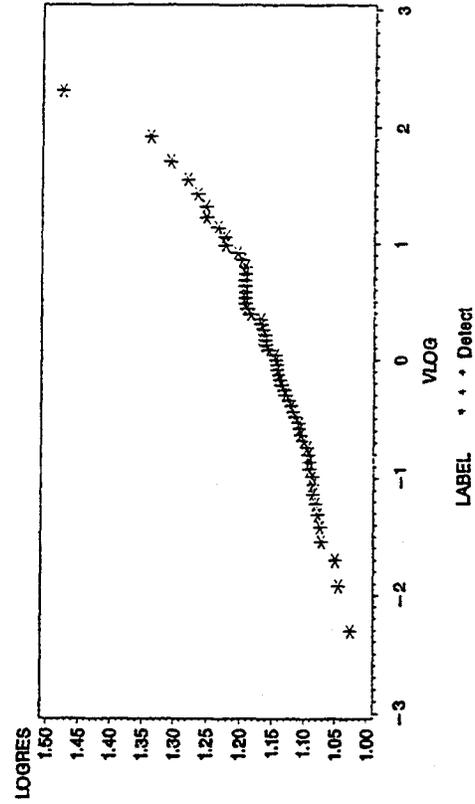
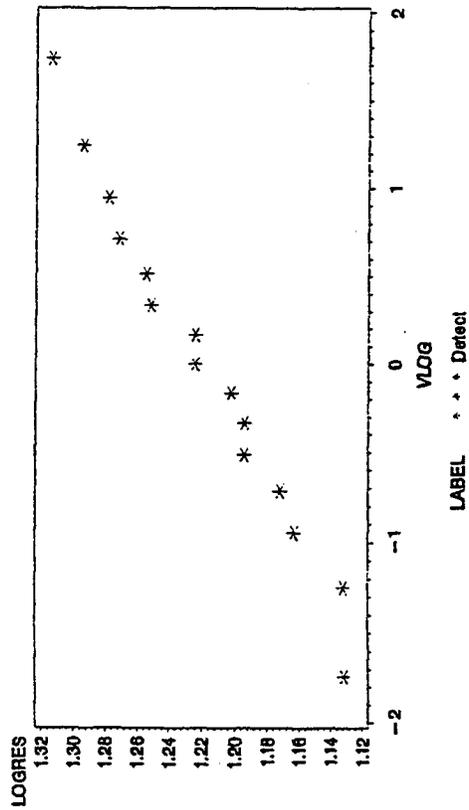
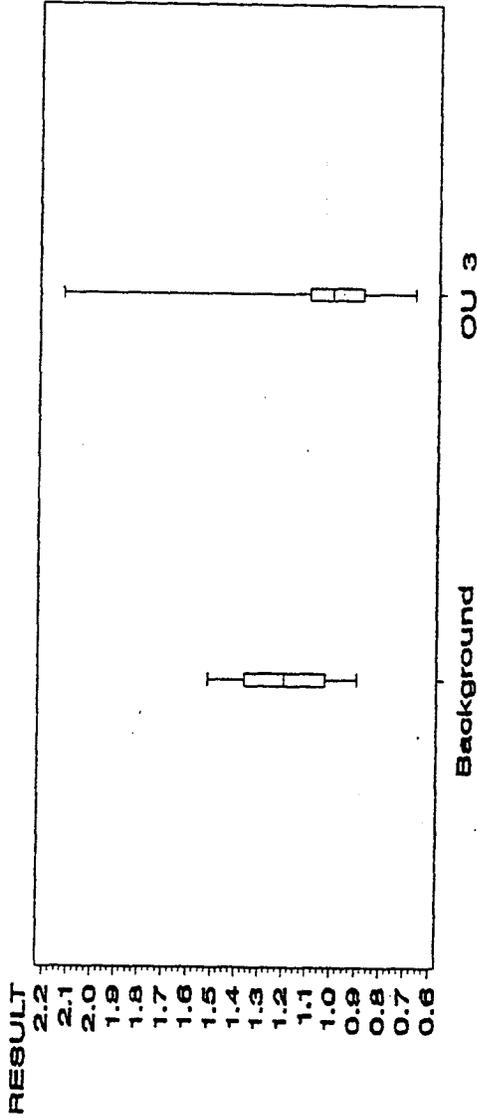


Figure B-9 - Probability Plots for IHSS 199 Surface Soil Data 238U

(This figure is a draft version;  
 it will be revised for the next draft of TM 4.)

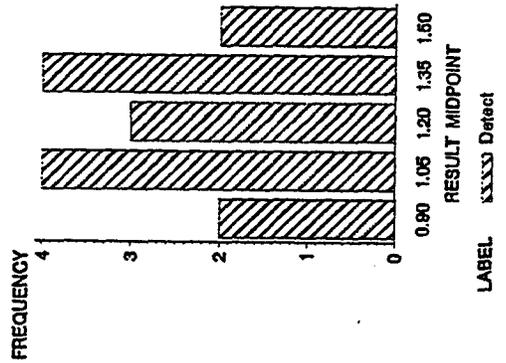
# Box Plots and Histograms of OU 3 Plus Jeffco SS Data

CHEMICAL = URANIUM - 238  
PCI/G



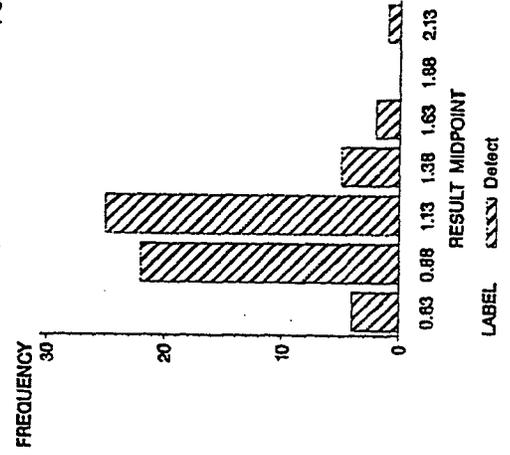
Area = Background

CHEMICAL = URANIUM - 238  
PCI/G



Area = OU 3

CHEMICAL = URANIUM - 238  
PCI/G



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- Figure B-9 – Probability Plots for IHSS 199 Surface Soil Data <sup>238</sup>U
- Figure B-10 – Box Plots and Histograms for IHSS 199 Surface Soil Data <sup>238</sup>U

Probability plots provide a graphical means for analyzing the distribution of the data. On a probability plot, if the data are from a normal distribution, the plotted values fall on a straight line extending from the lower left corner of the display towards the upper right corner. The data were also log transformed and plotted again to check for a lognormal distribution of the data. For example, the Shapiro-Wilk distribution tests for <sup>241</sup>Am are consistent with Figure B-1. In Figure B-1 background <sup>241</sup>Am data appear to be on a somewhat straight line for data, and log transformed data, indicating normality and lognormality, whereas the <sup>241</sup>Am OU 3 site data appear curved in the graphs, indicating the data follow neither normality or lognormality.

A histogram is a pictorial representation of a frequency distribution. It shows the shape of the distribution and the frequency of different data values. The histograms shown in this appendix show the frequency of detect and nondetect values for OU 3 surface soil and background.

Box plots are a graphical comparison of OU 3 surface soil data and background data. The box portion of each plot covers 50 percent of the data values, from the 25th to the 75th percentile. A horizontal line within the box indicates the median data value. The lines extending from each box reach adjacent values, which cover the range of the data set excluding outliers. Outliers are denoted with an "x." For example, the box plot for <sup>241</sup>Am shows the background data to have much less variation as well as a lower median. This is consistent with the statistical tests performed.

## REFERENCES

Gilbert, 1993. Richard O. Gilbert. Recommended process for implementation by Rocky Flats Environmental Technology Site (RFETS) to compare environmental restoration site analytical results obtained in operable units (OU) to background concentrations. July 30, 1993.

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## APPENDIX C. SUMMARY STATISTICS

Appendix C presents a statistical summary of OU 3 data for surface soil, sediment, surface water, and groundwater for each IHSS and type (e.g., reservoir or stream). It should be noted that the summary statistics were developed after data protocols were applied but before the COC selection process. Summary statistics were performed on the RFEDS OU 3 data analysis source table. The summary statistics for each analyte by IHSS and type include number of detects, number of samples, frequency of detection, minimum and maximum nondetected values, minimum and maximum detected values, arithmetic and geometric means, standard deviation, normal 95 percent UCL, and lognormal 95 percent UCL.

The normal 95 percent UCL is the upper 95 percent confidence limit on the arithmetic mean under the assumption that the distribution is normal, using t-statistics (EPA, 1992). The lognormal 95 percent UCL is the upper 95 percent confidence limit on the arithmetic mean under the assumption that the distribution is lognormal, using h-statistics (Gilbert, 1987; EPA, 1992).

The following is a list of summary statistics tables grouped by media, IHSS, and type:

- Table C-1 – IHSS 199 Surface-Soil Samples
- Table C-2 – Jefferson County Remedy acres Surface Soil Samples
- Table C-3 – IHSS 200 Great Western Reservoir: Reservoir Sediment Grab Samples
- Table C-4 – IHSS 200 Great Western Reservoir: Stream Sediment Grab Samples
- Table C-5 – IHSS 200 Great Western Reservoir: Reservoir Sediment Core Samples
- Table C-6 – IHSS 201 Standley Lake: Reservoir Sediment Grab Samples

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- Table C-7 – IHSS 201 Standley Lake: Stream Sediment Grab Samples
- Table C-8 – IHSS 202 Mower Reservoir: Reservoir Sediment Grab Samples
- Table C-9 – IHSS 202 Mower Reservoir: Stream Sediment Grab Samples
- Table C-10 – IHSS 200 Great Western Reservoir: Reservoir Surface Water Samples
- Table C-11 – IHSS 200 Great Western Reservoir: Stream Surface Water Samples
- Table C-12 – IHSS 201 Standley Lake: Reservoir Surface Water Samples
- Table C-13 – IHSS 201 Standley Lake: Stream Surface Water Samples
- Table C-14 – IHSS 202 Mower Reservoir: Reservoir Surface Water Samples
- Table C-15 – IHSS 200 Great Western Reservoir Groundwater Samples
- Table C-16 – IHSS 201 Standley Lake Groundwater Samples

#### REFERENCES

**EPA, 1992.** United States Environmental Protection Agency. Supplemental Guidance to RAGS: Calculating the Concentration Term. Office of Solid Waste and Emergency Response. Washington, D.C. (9285.7-08). May 1992.

**Gilbert, 1987.** Richard O. Gilbert. Statistical Methods for Environmental Pollution Monitoring. New York: Van Nostrand Reinhold Publishers.

RFI/RI Surface Soil Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
											Mean	Mean	Mean	Mean			
Radionuclides	T	AMERICIUM-241	pCi/g	57	57	1.000			-.002	.520	.035	.017	.072	.051	.090	*	
Radionuclides	T	PLUTONIUM-238	pCi/g	4	4	1.000			.001	.004	.002	.002	.001	.004	.022		
Radionuclides	T	PLUTONIUM-239/240	pCi/g	61	61	1.000			.008	2.950	.158	.057	.400	.245	.188		
Radionuclides	T	URANIUM-233/234	pCi/g	60	60	1.000			.530	2.140	1.014	.986	.256	1.070	1.067		
Radionuclides	T	URANIUM-235	pCi/g	60	60	1.000			.013	.124	.049	.044	.023	.054	.055		
Radionuclides	T	URANIUM-238	pCi/g	60	60	1.000			.670	2.132	1.038	1.013	.250	1.093	1.090	*	

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

RFI/RI surface soil results are the averages of the CDH and the RFP (MHM) sample collection method results.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-2  
Jefferson County Remedy Acres  
Surface Soil Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Radionuclides	T	AMERICIUM-241	pci/g	36	36	1.000			.041	.363	.143	.122	.080	.166	.175
Radionuclides	T	PLUTONIUM-238	pci/g	48	48	1.000			0.000	.047	.012	.010	.010	.015	.029 *
Radionuclides	T	PLUTONIUM-239/240	pci/g	48	48	1.000			.162	6.468	1.011	.747	1.031	1.263	1.250

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-3  
IHSS 200: Great Western Reservoir  
Reservoir Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal		Lognormal
											Mean	Mean	Mean	95% UCL (1)		95% UCL (2) *		
Metals	T	ALUMINUM	mg/kg	36	36	1,000			4530.000	20800.000	10910.833	10116.656	4212.310	12114.992	12432.291			
Metals	T	ANTIMONY	mg/kg	6	15	.400	2.400	3.100	5.900	13.200	5.017	4.156	3.488	6.603	7.121			
Metals	T	ARSENIC	mg/kg	36	36	1,000			2.600	9.400	4.906	4.713	1.460	5.323	5.344			
Metals	T	BARIUM	mg/kg	36	36	1,000			38.200	190.000	128.989	122.157	38.710	140.055	145.444			
Metals	T	BERYLLIUM	mg/kg	36	36	1,000			.370	1.400	.850	.807	.266	.926	.947			
Metals	T	CADMIUM	mg/kg	14	36	.389	.200	.445	.580	1.700	.568	.442	.431	.691	.718			
Metals	T	CALCIUM	mg/kg	36	36	1,000			3260.000	33900.000	7465.000	6329.443	5909.622	9154.364	8504.411			
Metals	T	CESIUM	mg/kg	9	36	.250	6.900	78.500	14.100	29.700	36.006	26.093	26.061	43.456	52.140			
Metals	T	CHROMIUM	mg/kg	36	36	1,000			3.700	19.800	10.947	10.230	3.787	12.030	12.483			
Metals	T	COBALT	mg/kg	36	36	1,000			3.500	13.500	8.664	8.395	2.033	9.245	9.430			
Metals	T	COPPER	mg/kg	36	36	1,000			8.100	129.000	48.567	36.306	37.571	59.307	65.654			
Metals	T	CYANIDE	mg/kg	0	21	0.000	.350	.800			.526	.506	.150	.582	.593			
Metals	T	IRON	mg/kg	36	36	1,000			4670.000	53900.000	16888.333	15242.849	8712.934	19379.071	19505.100			
Metals	T	LEAD	mg/kg	36	36	1,000			13.000	88.200	31.372	27.365	18.612	36.693	36.588			
Metals	T	LITHIUM	mg/kg	36	36	1,000			3.100	17.600	8.958	8.424	3.086	9.840	10.095			
Metals	T	MAGNESIUM	mg/kg	36	36	1,000			1280.000	5140.000	2871.667	2763.957	791.799	3098.016	3137.196			
Metals	T	MANGANESE	mg/kg	36	36	1,000			40.500	813.000	425.914	354.022	211.904	486.490	591.958			
Metals	T	MERCURY	mg/kg	4	36	.111	.030	.075	.100	.200	.063	.058	.032	.072	.071			
Metals	T	MOLYBDENUM	mg/kg	23	36	.639	.240	.850	.580	13.300	3.077	1.451	3.467	4.068	6.514			
Metals	T	NICKEL	mg/kg	36	36	1,000			5.700	22.700	15.725	15.129	3.964	16.858	17.349			
Metals	T	POTASSIUM	mg/kg	36	36	1,000			402.000	2700.000	1573.750	1437.355	598.930	1744.964	1859.155			
Metals	T	SELENIUM	mg/kg	13	22	.591	.100	1.100	.240	4.000	.888	.554	1.038	1.269	1.468			
Metals	T	SILICON	mg/kg	15	15	1,000			115.000	650.000	237.667	217.835	125.306	294.642	291.172			
Metals	T	SILVER	mg/kg	28	36	.778	.255	.950	1.100	6.000	1.917	1.568	1.128	2.239	2.600			
Metals	T	SODIUM	mg/kg	36	36	1,000			43.200	997.000	268.389	196.725	240.310	337.086	350.741			
Metals	T	STRONTIUM	mg/kg	36	36	1,000			26.700	154.000	57.828	54.231	24.189	64.742	63.920			
Metals	T	THALLIUM	mg/kg	1	36	.028	.175	1.300	.950	.950	.398	.340	.262	.472	.464			

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.  
 (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-3  
IHSS 200: Great Western Reservoir  
Reservoir Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Freq	Detect		Minimum		Maximum		Maximum Detected	Arithmetic Mean		Geometric Mean		Standard Deviation	Normal 95% UCL		Lognormal 95% UCL
							Non-detect	Detect	Non-detect	Detect	Non-detect	Detect		Non-detect	Detect	Non-detect	Detect				
Metals	T	TIN	mg/kg	7	33	.212	.800	4.050	2.600	6.100	1.964	1.667	1.300	2.352	2.347						
Metals	T	VANADIUM	mg/kg	36	36	1.000			9.100	70.700	31.839	29.106	13.495	35.697	37.023						
Metals	T	ZINC	mg/kg	36	36	1.000			28.500	540.000	195.339	149.490	145.761	237.007	260.160						
Radionuclides	T	AMERICIUM-241	pCi/g	34	34	1.000			0.000	.206	.043	.029	.052	.058	.242 *						
Radionuclides	T	CESIUM-137	pCi/g	14	14	1.000			.031	.190	.080	.067	.052	.104	.112						
Radionuclides	T	PLUTONIUM-239/240	pCi/g	87	87	1.000			0.000	3.300	.267	.088	.595	.374	.748 *						
Radionuclides	T	RADIUM-226	pCi/g	14	14	1.000			.840	2.200	1.124	1.089	.342	1.285	1.270						
Radionuclides	T	RADIUM-228	pCi/g	14	14	1.000			.920	2.200	1.444	1.401	.373	1.621	1.650						
Radionuclides	T	STRONTIUM-89/90	pCi/g	13	13	1.000			.110	.570	.309	.278	.143	.380	.425						
Radionuclides	T	TRITIUM	pCi/l	9	9	1.000			-36.000	160.900	76.244	24.031	78.207	124.733	9.3339e+041 *						
Radionuclides	T	URANIUM-233/234	pCi/g	35	35	1.000			.320	5.400	1.345	1.198	.827	1.585	1.550						
Radionuclides	T	URANIUM-235	pCi/g	35	35	1.000			0.000	.560	.071	.055	.092	.098	.401 *						
Radionuclides	T	URANIUM-238	pCi/g	35	35	1.000			.310	4.400	1.339	1.211	.696	1.540	1.546						

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-4  
 IHSS 200: Great Western Reservoir  
 Stream Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation		Normal 95% UCL (1)	Lognormal 95% UCL (2) *
							Nondetect	Detected				Mean	Detected	Mean	Detected	Mean	Detected		
Metals	T	ALUMINIUM	mg/kg	8	8	1.000			2220.000	13800.000	8233.750	7274.821	3848.049	10811.880	14912.672				
Metals	T	ANTIMONY	mg/kg	5	8	.625	1.800	2.400	6.500	11.300	6.469	5.225	3.844	9.044	15.638				
Metals	T	ARSENIC	mg/kg	8	8	1.000			3.700	9.400	5.313	5.083	1.850	6.552	6.750				
Metals	T	BARIIUM	mg/kg	8	8	1.000			78.600	243.000	136.713	129.593	50.489	170.539	180.771				
Metals	T	BERYLLIUM	mg/kg	8	8	1.000			.240	1.600	.851	.765	.380	1.106	1.446				
Metals	T	CADMIUM	mg/kg	3	8	.375	.215	.305	.410	1.600	.590	.426	.567	.970	1.433				
Metals	T	CALCIUM	mg/kg	8	8	1.000			1570.000	18300.000	7762.500	6140.388	5522.522	11462.500	18922.696				
Metals	T	CESIUM	mg/kg	0	8	0.000	44.950	66.500			53.381	52.876	8.027	58.759	59.310				
Metals	T	CHROMIUM	mg/kg	6	8	.750	.190	.265	2.400	12.700	4.894	2.400	4.612	7.985	162.899				
Metals	T	COBALT	mg/kg	8	8	1.000			4.500	23.300	11.250	10.009	6.001	15.271	18.175				
Metals	T	COPPER	mg/kg	8	8	1.000			8.900	37.500	20.525	19.143	8.204	26.022	29.194				
Metals	T	IRON	mg/kg	8	8	1.000			9430.000	51700.000	25816.250	22372.159	14443.510	35493.166	45976.678				
Metals	T	LEAD	mg/kg	8	8	1.000			5.300	36.200	18.513	16.307	9.358	24.782	32.826				
Metals	T	LITHIUM	mg/kg	8	8	1.000			1.800	11.500	6.650	5.856	3.193	8.789	12.095				
Metals	T	MAGNESIUM	mg/kg	8	8	1.000			684.000	4180.000	2305.500	2062.190	1039.534	3001.971	3964.527				
Metals	T	MANGANESE	mg/kg	8	8	1.000			155.000	1550.000	684.000	527.683	526.556	1036.784	1692.150				
Metals	T	MERCURY	mg/kg	0	8	0.000	.035	.065			.046	.045	.012	.054	.056				
Metals	T	MOLYBDENUM	mg/kg	6	8	.750	.800	.800	3.600	17.900	7.838	4.824	6.299	12.058	66.987				
Metals	T	NICKEL	mg/kg	8	8	1.000			10.000	72.700	25.200	20.667	20.311	38.808	45.940				
Metals	T	POTASSIUM	mg/kg	8	8	1.000			548.000	2090.000	1210.375	1094.917	579.405	1598.567	1875.781				
Metals	T	SELENIUM	mg/kg	6	8	.750	.105	.110	.440	.770	.487	.391	.260	.661	1.381				
Metals	T	SILICON	mg/kg	8	8	1.000			128.000	1020.000	459.125	342.672	365.615	704.081	1240.177				
Metals	T	SILVER	mg/kg	7	8	.875	.255	.255	1.200	4.000	2.382	1.854	1.351	3.287	8.486				
Metals	T	SODIUM	mg/kg	8	8	1.000			57.700	2490.000	535.588	268.282	811.745	1079.444	2976.091				
Metals	T	STRONTIUM	mg/kg	8	8	1.000			15.000	91.300	55.375	48.010	27.225	73.615	106.937				
Metals	T	THALLIUM	mg/kg	0	8	0.000	.160	.225			.199	.198	.023	.214	.217				
Metals	T	TIN	mg/kg	0	4	0.000	.850	1.950			1.413	1.315	.594	2.111	3.429				

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.
- (\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-4  
IHSS 200: Great Western Reservoir  
Stream Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL	Normal 95% UCL (1)	Normal 95% UCL (2)	Lognormal
Metals	T	VANADIUM	mg/kg	8	8	1,000			16.100	87.700	33.913	29.696	22.620	49.068	49.068	52.944	
Metals	T	ZINC	mg/kg	8	8	1,000			46.700	460.000	149.113	115.243	134.244	239.054	239.054	317.854	
Radionuclides	T	AMERICIUM-241	pCi/g	5	5	1,000			.001	.061	.017	.007	.025	.041	.041	10.075	
Radionuclides	T	CESIUM-137	pCi/g	6	6	1,000			.051	.570	.179	.113	.206	.348	.348	1.090	
Radionuclides	T	PLUTONIUM-239/240	pCi/g	8	8	1,000			0.000	.550	.156	.102	.202	.291	8.8178e+006 *		
Radionuclides	T	RADIUM-226	pCi/g	6	6	1,000			.850	1.200	1.067	1.057	.154	1.193	1.193	1.221	
Radionuclides	T	RADIUM-228	pCi/g	6	6	1,000			.970	1.700	1.328	1.311	.234	1.521	1.521	1.571	
Radionuclides	T	STRONTIUM-89/90	pCi/g	6	6	1,000			.130	.320	.220	.207	.081	.287	.287	.334	
Radionuclides	T	TRITIUM	pCi/l	4	4	1,000			-81.000	9300.000	2363.948	101.370	4625.182	7805.474	6.7070e+153 *		
Radionuclides	T	URANIUM-233/234	pCi/g	7	7	1,000			.940	2.656	1.369	1.292	.584	1.798	1.798	1.857	
Radionuclides	T	URANIUM-235	pCi/g	7	7	1,000			.025	.202	.072	.057	.062	.117	.117	.166	
Radionuclides	T	URANIUM-238	pCi/g	7	7	1,000			.870	2.229	1.400	1.328	.506	1.771	1.771	1.923	

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

IHSS 200: Great Western Reservoir  
Reservoir Sediment Core Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Maximum Detected	Arithmetic		Geometric		Standard Deviation		Normal		Lognormal
							Minimum	Nondetect	Maximum	Nondetect		Mean	Standard Deviation	Mean	Standard Deviation	95% UCL (1)	95% UCL (2) *			
Metals	T	ALUMINIUM	mg/kg	46	46	1.000		6340.000	26100.000	13893.696	12938.946	5457.016	15261.182	15396.620						
Metals	T	ARSENIC	mg/kg	46	46	1.000		3.600	10.400	6.489	6.285	1.667	6.907	6.944						
Metals	T	BARIIUM	mg/kg	46	46	1.000		81.900	205.000	161.607	158.721	28.962	168.864	170.406						
Metals	T	BERYLLIUM	mg/kg	46	46	1.000		.530	2.300	1.133	1.087	.331	1.216	1.228						
Metals	T	CADMIUM	mg/kg	22	46	.478	.190	.590	2.600	.744	.533	.624	.900	.979						
Metals	T	CALCIUM	mg/kg	46	46	1.000		3900.000	15400.000	7568.696	7228.752	2482.670	8190.834	8181.655						
Metals	T	CESIUM	mg/kg	26	46	.565	6.350	12.700	39.200	16.741	15.160	7.643	18.657	19.058						
Metals	T	CHROMIUM	mg/kg	46	46	1.000		6.800	28.100	15.026	14.103	5.500	16.404	16.568						
Metals	T	COBALT	mg/kg	46	46	1.000		5.900	12.200	9.352	9.249	1.379	9.698	9.727						
Metals	T	COPPER	mg/kg	46	46	1.000		15.800	311.000	94.689	65.396	78.636	114.395	133.578						
Metals	T	CYANIDE	mg/kg	0	46	0.000	.335	.750	.491	.477	.119	.521	.524	.524						
Metals	T	IRON	mg/kg	46	46	1.000		9330.000	25600.000	17028.913	16550.799	4005.914	18032.764	18174.828						
Metals	T	LEAD	mg/kg	46	46	1.000		14.500	126.000	47.211	39.876	27.017	53.981	57.223						
Metals	T	LITHIUM	mg/kg	46	46	1.000		5.400	19.600	11.663	11.019	3.899	12.640	12.835						
Metals	T	MAGNESIUM	mg/kg	46	46	1.000		1850.000	5080.000	3340.217	3234.140	842.843	3551.427	3580.257						
Metals	T	MANGANESE	mg/kg	46	46	1.000		153.000	772.000	363.804	328.728	158.987	403.645	417.781						
Metals	T	MERCURY	mg/kg	34	46	.739	.030	.070	.300	.149	.117	.086	.171	.203						
Metals	T	MOLYBDENUM	mg/kg	13	46	.283	.215	.840	5.000	.870	.538	1.111	1.149	1.053						
Metals	T	NICKEL	mg/kg	46	46	1.000		11.200	23.600	17.237	17.007	2.808	17.941	18.000						
Metals	T	POTASSIUM	mg/kg	46	46	1.000		973.000	4000.000	2155.065	2008.984	804.889	2356.764	2399.077						
Metals	T	SELENIUM	mg/kg	5	46	.109	.415	.860	2.450	.750	.710	.324	.831	.804						
Metals	T	SILVER	mg/kg	35	46	.761	.460	1.000	16.500	3.479	2.236	3.853	4.445	4.731						
Metals	T	SODIUM	mg/kg	46	46	1.000		74.600	224.000	136.046	132.925	29.685	143.484	144.060						
Metals	T	STRONTIUM	mg/kg	46	46	1.000		35.000	88.400	61.052	59.712	12.538	64.194	64.674						
Metals	T	THALLIUM	mg/kg	0	46	0.000	.180	.600	.351	.332	.123	.382	.385	.385						
Metals	T	TIN	mg/kg	17	46	.370	.800	1.700	6.000	2.155	1.763	1.471	2.524	2.566						
Metals	T	VANADIUM	mg/kg	46	46	1.000		17.200	60.400	36.113	34.460	11.276	38.939	39.241						

NOTES: Source table for summary statistics was DA091994.db.  
Concentration values should be considered significant to only two places.  
T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.
- (\*) A \*\*\* in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

IHSS 200: Great Western Reservoir  
Reservoir Sediment Core Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal		Lognormal
											Mean	Mean	Mean	95% UCL (1)		95% UCL (2)		
Metals	T	ZINC	mg/kg	46	46	1.000			46.200	480.000	186.648	153.700	108.625	213.868	233.441			
Radionuclides	T	AMERICIUM-241	pCi/g	40	40	1.000			-0.004	1.016	.237	.086	.311	.321	43.226	*		
Radionuclides	T	PLUTONIUM-239/240	pCi/g	60	60	1.000			-0.002	4.030	.729	.240	1.067	.963	600.208	*		
Radionuclides	T	POLONIUM-210	pCi/g	41	41	1.000			1.050	3.140	1.996	1.920	.529	2.137	2.173			
Radionuclides	T	URANIUM-233/234	pCi/g	64	64	1.000			.753	3.900	1.320	1.276	.413	1.407	1.389			
Radionuclides	T	URANIUM-235	pCi/g	64	64	1.000			-0.007	.210	.060	.056	.038	.068	.273	*		
Radionuclides	T	URANIUM-238	pCi/g	64	64	1.000			.720	3.300	1.368	1.326	.371	1.446	1.442			

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-6  
IHSS 201: Standley Lake  
Reservoir Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Minimum Detected	Maximum Detected	Arithmetic Mean		Geometric Mean		Standard Deviation	Normal		Lognormal
							Nondetect	Detect	Nondetect	Detect			Mean	SD	95% UCL (1)	95% UCL (2) *				
Metals	T	ALUMINUM	mg/kg	43	43	1,000					852,000	23500,000	9834,814	7271,442	6623,006	11551,408	14638,776			
Metals	T	ANTIMONY	mg/kg	3	21	.143	1,750	7,550			4,900	6,900	3,181	2,863	1,717	3,827	3,810			
Metals	T	ARSENIC	mg/kg	43	43	1,000					1,200	17,700	6,963	5,525	4,339	8,087	9,216			
Metals	T	BARIIUM	mg/kg	43	43	1,000					10,800	196,000	101,372	82,051	56,650	116,055	136,213			
Metals	T	BERYLLIUM	mg/kg	39	43	.907	.060	.070			.150	1,600	.700	.511	.467	.821	1,074			
Metals	T	CADMIUM	mg/kg	22	37	.595	.175	.295			.540	5,000	1,719	.919	1,600	2,170	3,529			
Metals	T	CALCIUM	mg/kg	43	43	1,000					427,000	90100,000	8091,930	4888,254	14021,390	11726,086	10162,211			
Metals	T	CESIUM	mg/kg	0	37	0,000	5,800	71,000					26,968	16,620	25,389	34,127	40,604			
Metals	T	CHROMIUM	mg/kg	40	43	.930	.215	.240			.890	21,400	9,897	6,317	6,913	11,689	21,645			
Metals	T	COBALT	mg/kg	43	43	1,000					1,300	13,200	7,049	6,017	3,531	7,964	8,807			
Metals	T	COPPER	mg/kg	43	43	1,000					1,200	183,000	67,919	33,134	64,897	84,739	165,239			
Metals	T	CYANIDE	mg/kg	0	21	0,000	.305	1,250					.440	.415	.199	.515	.493			
Metals	T	IRON	mg/kg	43	43	1,000					3100,000	28300,000	14866,512	13135,853	6835,610	16638,210	17770,914			
Metals	T	LEAD	mg/kg	43	43	1,000					2,900	317,000	63,747	33,094	67,107	81,140	124,259			
Metals	T	LITHIUM	mg/kg	42	43	.977	.240	.240			.530	17,100	7,529	5,444	4,835	8,782	12,559			
Metals	T	MAGNESTIUM	mg/kg	43	43	1,000					197,000	6430,000	2683,442	2051,071	1632,540	3106,574	3960,443			
Metals	T	MANGANESE	mg/kg	43	43	1,000					89,600	2080,000	595,379	391,826	592,161	748,859	815,368			
Metals	T	MERCURY	mg/kg	18	42	.429	0,000	.100			.080	.600	.116	.103	.123	.149	5,572 *			
Metals	T	MOLYBDENUM	mg/kg	20	37	.541	.195	1,250			.690	7,700	1,910	.947	2,172	2,523	3,586			
Metals	T	NICKEL	mg/kg	40	43	.930	1,200	1,350			3,400	23,700	12,338	9,981	6,636	14,058	17,090			
Metals	T	POTASSIUM	mg/kg	43	43	1,000					183,000	3630,000	1734,512	1311,344	1138,906	2029,701	2439,708			
Metals	T	SELENIUM	mg/kg	9	32	.281	.095	3,550			.180	4,500	.892	.547	1,024	1,203	1,434			
Metals	T	SILICON	mg/kg	13	13	1,000					82,000	396,000	197,308	183,951	79,131	236,417	249,057			
Metals	T	SILVER	mg/kg	31	35	.886	.225	.500			.480	7,700	1,995	1,391	1,775	2,510	2,912			
Metals	T	SODIUM	mg/kg	43	43	1,000					26,000	509,000	138,735	113,651	96,812	163,827	169,036			
Metals	T	STRONTIUM	mg/kg	43	43	1,000					2,800	423,000	49,812	34,749	62,008	65,883	69,965			
Metals	T	THALLIUM	mg/kg	0	38	0,000	.230	1,950					.481	.393	.400	.592	.558			

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "##" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-6  
IHSS 201: Standley Lake  
Reservoir Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
											Mean	Mean	Mean	Mean			
Metals	T	TIN	mg/kg	20	36	.556	.800	5.750	2.000	10.400	3.192	2.483	2.344	3.862	4.153		
Metals	T	VANADIUM	mg/kg	43	43	1.000			4.900	50.000	24.300	20.915	12.173	27.455	29.864		
Metals	T	ZINC	mg/kg	43	43	1.000			9.000	1120.000	425.593	199.955	392.510	527.326	1164.353		
Radionuclides	T	AMERICIUM-241	pci/g	39	39	1.000			0.000	.107	.017	.011	.023	.024	.057 *		
Radionuclides	T	CESIUM-137	pci/g	8	8	1.000			.042	.055	.048	.048	.005	.051	.051		
Radionuclides	T	PLUTONIUM-239/240	pci/g	105	105	1.000			-.015	.553	.033	.037	.060	.043	1.432 *		
Radionuclides	T	RADIUM-226	pci/g	8	8	1.000			.280	1.400	.790	.712	.348	1.023	1.302		
Radionuclides	T	RADIUM-228	pci/g	8	8	1.000			.310	1.600	1.000	.866	.495	1.331	1.918		
Radionuclides	T	STRONTIUM-89/90	pci/g	8	8	1.000			.140	.720	.326	.289	.186	.451	.517		
Radionuclides	T	URANIUM-233/234	pci/g	37	37	1.000			.220	2.671	1.238	1.011	.722	1.442	1.631		
Radionuclides	T	URANIUM-235	pci/g	37	37	1.000			-.002	.115	.045	.056	.034	.055	5.499 *		
Radionuclides	T	URANIUM-238	pci/g	37	37	1.000			.200	2.418	1.223	1.005	.698	1.420	1.600		

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this station only.) The actual meaning of this result is questionable.

Table C-7  
IHSS 201: Standley Lake  
Stream Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	T	ALUMINIUM	mg/kg	14	14	1.000			1900.000	33200.000	8030.714	6026.316	7958.467	11797.613	12700.372
Metals	T	ANTIMONY	mg/kg	1	13	.077	2.300	6.700	6.400	6.400	3.708	3.427	1.603	4.500	4.696
Metals	T	ARSENIC	mg/kg	14	14	1.000			2.200	7.800	4.764	4.522	1.529	5.488	5.780
Metals	T	BARIUM	mg/kg	14	14	1.000			85.000	329.000	150.714	142.448	59.753	178.996	179.482
Metals	T	BERYLLIUM	mg/kg	14	14	1.000			.220	1.500	.577	.518	.311	.724	.755
Metals	T	CADMIUM	mg/kg	7	14	.500	.210	.750	.770	6.300	1.802	1.094	1.792	2.650	4.626
Metals	T	CALCIUM	mg/kg	14	14	1.000			911.000	75000.000	13887.214	5833.987	20983.282	23819.014	50599.674
Metals	T	CESIUM	mg/kg	3	14	.214	6.950	104.500	3.100	19.900	40.850	24.474	32.843	56.395	152.052
Metals	T	CHROMIUM	mg/kg	14	14	1.000			2.700	31.900	8.807	7.307	7.145	12.189	12.315
Metals	T	COBALT	mg/kg	14	14	1.000			2.900	10.900	7.900	7.523	2.205	8.943	9.686
Metals	T	COPPER	mg/kg	14	14	1.000			12.900	52.300	30.293	27.604	13.266	36.572	39.548
Metals	T	CYANIDE	mg/kg	0	3	0.000	.330	.445			.382	.379	.058	.480	.527
Metals	T	IRON	mg/kg	14	14	1.000			5670.000	26600.000	15397.857	14508.811	5232.170	17874.346	19078.376
Metals	T	LEAD	mg/kg	14	14	1.000			17.200	91.400	38.450	33.912	21.057	48.417	52.184
Metals	T	LITHIUM	mg/kg	14	14	1.000			2.100	34.600	8.207	6.047	8.310	12.140	13.400
Metals	T	MAGNESIUM	mg/kg	14	14	1.000			595.000	9480.000	2531.071	1955.344	2234.404	3588.659	4043.359
Metals	T	MANGANESE	mg/kg	14	14	1.000			83.500	4450.000	1706.179	991.984	1447.028	2391.085	6667.564
Metals	T	MERCURY	mg/kg	3	14	.214	.025	.080	.080	.140	.061	.055	.031	.076	.080
Metals	T	MOLYBDENUM	mg/kg	6	14	.429	.350	2.300	1.600	6.700	2.379	1.824	1.865	3.261	4.152
Metals	T	NICKEL	mg/kg	13	14	.929	3.150	3.150	8.600	22.600	14.811	13.490	5.527	17.427	20.619
Metals	T	POTASSIUM	mg/kg	14	14	1.000			549.000	8390.000	1794.857	1330.038	1993.048	2738.206	2704.157
Metals	T	SELENIUM	mg/kg	3	14	.214	.100	.600	1.500	2.200	.598	.307	.741	.948	1.637
Metals	T	SILICON	mg/kg	8	8	1.000			281.000	3290.000	1167.500	926.495	937.246	1795.439	2539.985
Metals	T	SILVER	mg/kg	8	14	.571	.250	.750	.790	2.100	.942	.780	.583	1.218	1.466
Metals	T	SODIUM	mg/kg	14	14	1.000			51.500	1610.000	286.107	170.664	412.131	481.177	516.495
Metals	T	STRONTIUM	mg/kg	14	14	1.000			18.300	227.000	67.286	50.098	61.121	96.215	110.665
Metals	T	THALLIUM	mg/kg	2	14	.143	.120	.750	.280	.380	.256	.225	.163	.333	.337

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-7  
IHSS 201: Standley Lake  
Stream Sediment Grab Samples

Test Group	I/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
							Nondetect	Detected	Nondetect	Detected						
Metals	T	TIN	mg/kg	0	13	0.000	1.300	8.700				2.781	2.432	1.923	3.731	3.654
Metals	T	VANADIUM	mg/kg	14	14	1.000			11.200	60.900	26.029	23.950	12.113	31.762	32.778	
Metals	T	ZINC	mg/kg	14	14	1.000			53.000	1170.000	422.243	240.714	384.514	604.241	1383.612	
Radionuclides	T	AMERICIUM-241	pci/g	13	13	1.000			.001	.082	.022	.010	.027	.035	.110	
Radionuclides	T	PLUTONIUM-239/240	pci/g	14	14	1.000			-.007	.470	.082	.030	.161	.158	766.498 *	
Radionuclides	T	TRITIUM	pci/l	4	4	1.000			77.000	159.600	112.015	106.939	39.341	158.299	207.724	
Radionuclides	T	URANIUM-233/234	pci/g	14	14	1.000			.620	4.700	1.452	1.245	1.030	1.940	1.963	
Radionuclides	T	URANIUM-235	pci/g	14	14	1.000			.028	.200	.078	.068	.045	.099	.108	
Radionuclides	T	URANIUM-238	pci/g	14	14	1.000			.620	3.900	1.339	1.170	.842	1.737	1.795	

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-8  
IHSS 202: Mower Reservoir  
Reservoir Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
											Mean	Mean	Mean	Mean			
Metals	T	ALUMINIUM	mg/kg	15	15	1,000			7480.000	18300.000	14370.000	13995.097	3096.101	15777.761	16346.256		
Metals	T	ANTIMONY	mg/kg	1	6	.167	4.600	44.400	17.300	17.300	14.858	10.470	15.234	27.390	64.404		
Metals	T	ARSENIC	mg/kg	15	15	1,000			2.200	10.400	5.147	4.820	1.958	6.037	6.312		
Metals	T	BARIUM	mg/kg	15	15	1,000			103.000	250.000	173.000	166.284	47.920	194.788	202.085		
Metals	T	BERYLLIUM	mg/kg	13	14	.929	1.000	1.000	.540	1.500	1.061	1.027	.269	1.189	1.232		
Metals	T	CADMIUM	mg/kg	0	8	0.000	.350	3.950			.986	.678	1.216	1.801	2.266		
Metals	T	CALCIUM	mg/kg	15	15	1,000			7050.000	42000.000	15209.333	13727.942	8374.687	19017.205	19234.850		
Metals	T	CESIUM	mg/kg	1	9	.111	1.250	15.750	69.800	69.800	14.744	6.441	21.574	28.120	140.120		
Metals	T	CHROMIUM	mg/kg	14	15	.933	4.400	4.400	5.100	22.100	14.800	13.611	5.139	17.136	19.708		
Metals	T	COBALT	mg/kg	14	15	.933	5.850	5.850	4.400	15.300	8.357	8.020	2.550	9.516	9.729		
Metals	T	COPPER	mg/kg	14	15	.933	11.650	11.650	11.100	50.100	26.797	23.943	12.466	32.465	36.177		
Metals	T	CYANIDE	mg/kg	0	6	0.000	.600	.900			.767	.759	.121	.866	.888		
Metals	T	IRON	mg/kg	15	15	1,000			10800.000	48000.000	19886.667	18664.196	8631.989	23811.531	23677.158		
Metals	T	LEAD	mg/kg	15	15	1,000			14.500	40.800	29.987	28.843	7.745	33.508	35.281		
Metals	T	LITHIUM	mg/kg	14	15	.933	7.950	7.950	7.000	13.900	11.017	10.764	2.371	12.095	12.344		
Metals	T	MAGNESIUM	mg/kg	15	15	1,000			2480.000	5040.000	4064.000	4007.436	662.170	4365.081	4438.482		
Metals	T	MANGANESE	mg/kg	15	15	1,000			148.000	925.000	297.800	262.024	194.927	386.431	380.891		
Metals	T	MERCURY	mg/kg	1	8	.125	.035	.225	.100	.100	.081	.067	.062	.122	.140		
Metals	T	MOLYBDENUM	mg/kg	0	8	0.000	.415	15.400			3.389	1.652	5.018	6.751	22.550		
Metals	T	NICKEL	mg/kg	12	15	.800	4.850	29.900	10.500	29.200	17.087	15.632	6.700	20.133	22.608		
Metals	T	POTASSIUM	mg/kg	14	15	.933	2755.000	2755.000	1370.000	3450.000	2777.000	2694.742	639.000	3067.546	3189.597		
Metals	T	SELENIUM	mg/kg	3	11	.273	.145	1.600	1.900	5.700	1.723	.928	1.996	2.813	7.567		
Metals	T	SILVER	mg/kg	2	8	.250	.600	3.600	1.500	1.900	1.400	1.181	.989	2.063	2.465		
Metals	T	SODIUM	mg/kg	15	15	1,000			171.000	1080.000	369.333	335.768	210.387	464.994	454.746		
Metals	T	STRONTIUM	mg/kg	15	15	1,000			47.100	190.000	82.813	78.791	32.386	97.539	96.074		
Metals	T	THALLIUM	mg/kg	0	8	0.000	.145	1.200			.656	.472	.485	.981	2.273		
Metals	T	TIN	mg/kg	5	11	.455	1.950	58.000	16.400	51.400	22.968	14.250	19.407	33.571	94.802		

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-8  
IHSS 202: Mower Reservoir  
Reservoir Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	T	VANADIUM	mg/kg	15	15	1.000	18.600	114.000	18.600	114.000	42.987	39.523	21.529	52.775	53.041
Metals	T	ZINC	mg/kg	15	15	1.000	40.500	193.000	40.500	193.000	81.247	76.235	34.672	97.012	97.201
Organics	T	1,1,1-TRICHLOROETHANE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	1,1,2,2-TETRACHLOROETHANE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	1,1,2-TRICHLOROETHANE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	1,1-DICHLOROETHANE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	1,1-DICHLOROETHENE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	1,2-DICHLOROETHANE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	1,2-DICHLOROETHENE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	1,2-DICHLOROPROPANE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	2-BUTANONE	ug/kg	3	8	.375	7.500	14.500	4.000	14.000	10.313	9.593	3.741	12.819	15.242
Organics	T	2-HEXANONE	ug/kg	0	6	0.000	7.500	14.500	7.500	14.500	11.667	11.284	3.141	14.251	15.669
Organics	T	4-METHYL-2-PENTANONE	ug/kg	0	6	0.000	7.500	14.500	7.500	14.500	11.667	11.284	3.141	14.251	15.669
Organics	T	ACETONE	ug/kg	6	11	.545	11.000	55.000	11.000	47.000	31.818	27.673	15.602	40.342	50.636
Organics	T	BENZENE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	BROMODICHLOROMETHANE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	BROMOFORM	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	BROMOMETHANE	ug/kg	0	6	0.000	7.500	14.500	7.500	14.500	11.667	11.284	3.141	14.251	15.669
Organics	T	CARBON DISULFIDE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	CARBON TETRACHLORIDE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	CHLOROBENZENE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	CHLOROETHANE	ug/kg	0	6	0.000	7.500	14.500	7.500	14.500	11.667	11.284	3.141	14.251	15.669
Organics	T	CHLOROFORM	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	CHLOROMETHANE	ug/kg	0	6	0.000	7.500	14.500	7.500	14.500	11.667	11.284	3.141	14.251	15.669
Organics	T	CIS-1,3-DICHLOROPROPENE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954
Organics	T	DIBROMOCHLOROMETHANE	ug/kg	0	6	0.000	3.500	7.500	3.500	7.500	5.833	5.630	1.602	7.151	7.954

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A value in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-8  
IHSS 202: Mower Reservoir  
Reservoir Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal		Lognormal
														95% UCL (1)	95% UCL (2) *	
Organics	T	ETHYLBENZENE	ug/kg	0	6	0.000	3.500	7.500			5.833	5.630	1.602	7.151	7.954	
Organics	T	METHYLENE CHLORIDE	ug/kg	3	10	.300	7.000	10.500	2.000	5.000	7.300	6.604	2.850	8.952	11.243	
Organics	T	STYRENE	ug/kg	0	6	0.000	3.500	7.500			5.833	5.630	1.602	7.151	7.954	
Organics	T	TETRACHLOROETHENE	ug/kg	0	6	0.000	3.500	7.500			5.833	5.630	1.602	7.151	7.954	
Organics	T	TOLUENE	ug/kg	1	7	.143	3.500	7.500	16.000	16.000	7.286	6.536	4.112	10.305	11.823	
Organics	T	TOTAL XYLENES	ug/kg	0	6	0.000	3.500	7.500			5.833	5.630	1.602	7.151	7.954	
Organics	T	TRANS-1,3-DICHLOROPROPENE	ug/kg	0	6	0.000	3.500	7.500			5.833	5.630	1.602	7.151	7.954	
Organics	T	TRICHLOROETHENE	ug/kg	0	6	0.000	3.500	7.500			5.833	5.630	1.602	7.151	7.954	
Organics	T	UNKNOWN	ug/kg	1	1	1.000			9.000	9.000	9.000	9.000		7.151	7.954	
Organics	T	UNKNOWN-1	ug/kg	1	1	1.000			9.000	9.000	9.000	9.000		7.151	7.954	
Organics	T	UNKNOWN-2	ug/kg	1	1	1.000			24.000	24.000	24.000	24.000		7.151	7.954	
Organics	T	VINYL ACETATE	ug/kg	0	6	0.000	7.500	14.500			11.667	11.284	3.141	14.251	15.669	
Organics	T	VINYL CHLORIDE	ug/kg	0	6	0.000	7.500	14.500			11.667	11.284	3.141	14.251	15.669	
Radionuclides	T	AMERICIUM-241	pCi/g	15	15	1.000			.008	.093	.049	.041	.026	.061	.082	
Radionuclides	T	PLUTONIUM-239/240	pCi/g	15	15	1.000			.031	.488	.291	.211	.165	.366	.759	
Radionuclides	T	URANIUM-233/234	pCi/g	15	15	1.000			.660	3.500	1.407	1.316	.635	1.696	1.686	
Radionuclides	T	URANIUM-235	pCi/g	15	15	1.000			.012	.170	.064	.050	.043	.083	.111	
Radionuclides	T	URANIUM-238	pCi/g	15	15	1.000			.860	3.300	1.502	1.429	.565	1.759	1.751	

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.  
 (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-9  
IHSS 202: Mower Reservoir  
Stream Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	T	ALUMINUM	mg/kg	4	4	1,000			9110.000	15200.000	11227.500	11006.949	2718.153	14425.408	15659.248
Metals	T	ANTIMONY	mg/kg	1	4	.250	5.250	6.150	16.500	16.500	8.300	7.290	5.482	14.750	29.427
Metals	T	ARSENIC	mg/kg	4	4	1,000			3.000	6.800	4.875	4.677	1.565	6.716	8.780
Metals	T	BERNIUM	mg/kg	4	4	1,000			81.500	296.000	150.950	130.359	100.640	269.353	680.559
Metals	T	BERYLLIUM	mg/kg	3	3	1,000		.950	.410	1.400	.783	.677	.538	1.690	38.104
Metals	T	CADMIUM	mg/kg	0	4	0,000	.470				.593	.563	.238	.873	1.085
Metals	T	CALCIUM	mg/kg	4	4	1,000			6480.000	59400.000	22077.500	14738.528	25024.064	51518.311	901697.805
Metals	T	CESIUM	mg/kg	3	4	.750	126.500	126.500	1.800	2.000	33.050	5.424	62.300	106.346	8.6472e+008
Metals	T	CHROMIUM	mg/kg	4	4	1,000			6.800	17.000	12.650	11.793	5.124	18.679	31.173
Metals	T	COBALT	mg/kg	4	4	1,000			6.300	9.600	7.825	7.737	1.365	9.431	9.979
Metals	T	COPPER	mg/kg	4	4	1,000			7.300	18.200	11.125	10.463	4.832	16.810	22.831
Metals	T	IRON	mg/kg	4	4	1,000			14300.000	27000.000	19200.000	18578.466	5832.667	26062.132	30843.325
Metals	T	LEAD	mg/kg	4	4	1,000			12.300	21.600	16.775	16.448	3.810	21.257	23.721
Metals	T	LITHIUM	mg/kg	4	4	1,000			7.100	16.200	9.475	8.848	4.485	14.752	20.190
Metals	T	MAGNESIUM	mg/kg	4	4	1,000			2270.000	4460.000	2887.500	2767.971	1053.577	4127.034	4945.951
Metals	T	MANGANESE	mg/kg	4	4	1,000			238.000	1170.000	548.000	452.304	423.629	1046.399	3683.464
Metals	T	MERCURY	mg/kg	0	4	0,000	.025	.105			.045	.036	.040	.092	.354
Metals	T	MOLYBDENUM	mg/kg	0	4	0,000	1.800	2.100			1.900	1.897	.135	2.059	2.072
Metals	T	NICKEL	mg/kg	3	4	.750	3.550	3.550	14.900	16.900	12.588	10.761	6.095	19.758	123.309
Metals	T	POTASSIUM	mg/kg	4	4	1,000			1210.000	2760.000	1745.000	1658.186	691.400	2558.432	3259.938
Metals	T	SELENIUM	mg/kg	0	4	0,000	.110	.275			.190	.180	.068	.270	.382
Metals	T	SILICON	mg/kg	1	1	1,000			412.000	412.000	412.000	412.000			
Metals	T	SILVER	mg/kg	1	4	.250	.425	.430	1.900	1.900	.796	.622	.736	1.662	7.273
Metals	T	SODIUM	mg/kg	4	4	1,000			193.000	533.000	291.500	265.496	161.709	481.750	767.847
Metals	T	STRONTIUM	mg/kg	4	4	1,000			35.800	349.000	131.225	86.273	147.154	304.352	7354.741
Metals	T	THALLIUM	mg/kg	1	4	.250	.105	.425	.250	.250	.223	.187	.151	.400	1.452
Metals	T	TIN	mg/kg	0	3	0,000	4.950	6.950			6.250	6.177	1.127	8.150	9.766

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-9  
IHSS 202: Mower Reservoir  
Stream Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Freq	Minimum		Maximum		Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal		Lognormal
							Non-detect	Detect	Non-detect	Detect					95% UCL (1)	95% UCL (2) *	
Metals	T	VANADIUM	mg/kg	4	4	1.000	28.700	51.100	37.400	36.534	9.702	48.814	54.383				
Metals	T	ZINC	mg/kg	4	4	1.000	44.600	56.600	49.475	49.267	5.312	55.725	56.734				
Organics	T	1,1,1-TRICHLOROETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	1,1,2,2-TETRACHLOROETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	1,1,2-TRICHLOROETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	1,1-DICHLOROETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	1,1-DICHLOROETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	1,2-DICHLOROETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	1,2-DICHLOROETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	1,2-DICHLOROETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	1,2-DICHLOROPROPANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	2-BUTANONE	ug/kg	0	4	0.000	5.500	13.000	7.375	6.820	3.750	11.787	17.027				
Organics	T	2-HEXANONE	ug/kg	0	4	0.000	5.500	13.000	7.375	6.820	3.750	11.787	17.027				
Organics	T	4-METHYL-2-PENTANONE	ug/kg	0	4	0.000	5.500	13.000	7.375	6.820	3.750	11.787	17.027				
Organics	T	ACETONE	ug/kg	0	4	0.000	5.500	23.000	9.875	7.865	8.750	20.169	76.684				
Organics	T	BENZENE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	BROMODICHLOROMETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	BROMOFORM	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	BROMOMETHANE	ug/kg	0	4	0.000	5.500	13.000	7.375	6.820	3.750	11.787	17.027				
Organics	T	CARBON DISULFIDE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	CARBON TETRACHLORIDE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	CHLOROBENZENE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	CHLOROETHANE	ug/kg	0	4	0.000	5.500	13.000	7.375	6.820	3.750	11.787	17.027				
Organics	T	CHLOROFORM	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	CHLOROMETHANE	ug/kg	0	4	0.000	5.500	13.000	7.375	6.820	3.750	11.787	17.027				
Organics	T	CIS-1,3-DICHLOROPROPENE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				
Organics	T	DIBROMOCHLOROMETHANE	ug/kg	0	4	0.000	2.500	6.500	3.500	3.175	2.000	5.853	9.458				

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "u" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-9  
IHSS 202: Mower Reservoir  
Stream Sediment Grab Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal		Lognormal
							Nondetect	Detect	Nondetect	Detect					95% UCL (1)	95% UCL (2) *	
Organics	T	ETHYLENE CHLORIDE	ug/kg	0	4	0.000	2.500	6.500	6.500	0	0.000	3.500	3.175	2.000	5.853	9.458	
Organics	T	ETHYLENE CHLORIDE	ug/kg	0	4	0.000	2.500	6.500	6.500	0	0.000	4.500	4.031	2.309	7.217	16.442	
Organics	T	STYRENE	ug/kg	0	4	0.000	2.500	6.500	6.500	0	0.000	3.500	3.175	2.000	5.853	9.458	
Organics	T	TETRACHLOROETHENE	ug/kg	0	4	0.000	2.500	6.500	6.500	0	0.000	3.500	3.175	2.000	5.853	9.458	
Organics	T	TOLUENE	ug/kg	2	4	.500	2.500	6.500	6.500	2.000	9.000	5.000	4.136	3.342	8.931	43.570	
Organics	T	TOTAL XYLENES	ug/kg	1	4	.250	2.500	6.500	6.500	2.000	2.000	3.375	3.002	2.097	5.842	10.899	
Organics	T	TRANS-1,3-DICHLOROPROPENE	ug/kg	0	4	0.000	2.500	6.500	6.500	0	0.000	3.500	3.175	2.000	5.853	9.458	
Organics	T	TRICHLOROETHENE	ug/kg	0	4	0.000	2.500	6.500	6.500	0	0.000	3.500	3.175	2.000	5.853	9.458	
Organics	T	TRICHLOROTRIFLUOROETHANE	ug/kg	1	1	1.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	3.750	5.500	17.027	
Organics	T	VINYL ACETATE	ug/kg	0	3	0.000	5.500	5.500	5.500	0	0.000	5.500	5.500	3.750	11.787		
Organics	T	VINYL CHLORIDE	ug/kg	0	4	0.000	5.500	13.000	13.000	0	0.000	7.375	6.820	3.750	11.787		
Radionuclides	T	AMERICIUM-241	pci/g	4	4	1.000	.021	.046	.046	.046	.046	.030	.028	.011	.043	.054	
Radionuclides	T	PLUTONIUM-239/240	pci/g	4	4	1.000	.046	.171	.171	.171	.171	.091	.081	.055	.156	.326	
Radionuclides	T	URANIUM-233/234	pci/g	4	4	1.000	.960	2.090	2.090	2.090	2.090	1.288	1.219	.538	1.921	2.458	
Radionuclides	T	URANIUM-235	pci/g	4	4	1.000	.057	.140	.140	.140	.140	.085	.080	.037	.129	.174	
Radionuclides	T	URANIUM-238	pci/g	4	4	1.000	.790	2.150	2.150	2.150	2.150	1.205	1.107	.634	1.951	2.971	

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-10  
IHSS 200: Great Western Reservoir  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Minimum Detected	Maximum Detected	Arithmetic Mean		Geometric Mean		Standard Deviation	Normal		Lognormal
							Nondetect	Detect	Nondetect	Detect			Mean	Mean	95% UCL (1)	95% UCL (2) *				
Metals	D	ALUMINUM	ug/l	11	15	.733	7.350	8.650	15.200	3230.000	429.200	48.610	967.676	869.191	4392.606					
Metals	D	ANTIMONY	ug/l	0	15	0.000	7.400	8.250	2.400	2.400	7.740	7.729	.431	7.936	7.940					
Metals	D	ARSENIC	ug/l	3	15	.200	.950	1.450	2.400	2.400	1.473	1.397	.523	1.711	1.746					
Metals	D	BARIIUM	ug/l	15	15	1.000	.150	.200	32.500	48.900	38.100	37.824	4.851	40.306	40.399					
Metals	D	BERYLLIUM	ug/l	0	15	0.000	.700	.750	1.500	1.500	.170	.168	.025	.182	.182					
Metals	D	CADMIUM	ug/l	1	15	.067	.700	.750	17600.000	22000.000	.780	.764	.201	.871	.852					
Metals	D	CALCIUM	ug/l	15	15	1.000	25.000	25.000	50.000	60.000	19506.667	19472.285	1205.622	20054.849	20069.898					
Metals	D	CESIUM	ug/l	4	15	.267	1.300	1.850	32.333	30.443	1.520	1.497	.279	1.647	1.658					
Metals	D	CHROMIUM	ug/l	0	15	0.000	.650	1.150	1.900	1.900	.933	.877	.364	1.099	1.121					
Metals	D	COBALT	ug/l	1	15	.067	.950	1.200	2.000	9.400	2.990	2.145	2.682	4.209	5.190					
Metals	D	COPPER	ug/l	8	15	.533	2.000	8.150	6.600	572.000	91.807	34.089	150.185	162.893	553.641					
Metals	D	IRON	ug/l	11	14	.786	1.850	1.850	1.200	5.800	3.120	2.850	1.295	3.709	4.053					
Metals	D	LEAD	ug/l	15	15	1.000	3.800	8.200	3.800	8.200	5.563	5.288	1.573	6.278	6.806					
Metals	D	LITHIUM	ug/l	14	15	.933	3750.000	94.200	3750.000	4320.000	3999.333	3996.611	153.086	4068.940	4070.247					
Metals	D	MAGNESIUM	ug/l	15	15	1.000	.100	.100	.900	94.200	16.067	4.540	29.913	29.668	55.515					
Metals	D	MANGANESE	ug/l	5	15	.333	.130	.130	.130	.130	.110	.109	.015	.117	.117					
Metals	D	MERCURY	ug/l	15	15	1.000	2.000	7.000	2.000	7.000	4.727	4.480	1.507	5.412	5.713					
Metals	D	MOLYBDENUM	ug/l	1	15	.067	1.300	3.000	3.500	3.500	2.127	1.940	.923	2.546	2.721					
Metals	D	NICKEL	ug/l	15	15	1.000	1460.000	2030.000	1460.000	2030.000	1588.000	1582.422	145.612	1654.208	1651.804					
Metals	D	POTASSIUM	ug/l	0	15	0.000	1.450	1.900	469.000	2200.000	1.697	1.685	.203	1.789	1.797					
Metals	D	SELENIUM	ug/l	15	15	1.000	1.150	1.800	2.500	2.700	1.920	1.865	.663	1602.073	1889.387					
Metals	D	SILICON	ug/l	4	15	.267	1.150	1.800	7590.000	8610.000	1.920	1.865	.467	2.133	2.182					
Metals	D	SILVER	ug/l	15	15	1.000	115.000	147.000	115.000	147.000	132.733	132.405	276.426	8279.688	8282.831					
Metals	D	SODIUM	ug/l	15	15	1.000	.850	2.150	1.913	1.877	1.913	1.877	.318	137.110	137.329					
Metals	D	STRONTIUM	ug/l	0	15	0.000	3.100	6.250	4.360	4.104	4.360	4.104	1.597	2.058	2.151					
Metals	D	THALLIUM	ug/l	0	15	0.000	3.100	6.250	4.360	4.104	4.360	4.104	1.597	5.086	5.250					
Metals	D	TIN	ug/l	0	15	0.000	3.100	6.250	4.360	4.104	4.360	4.104	1.597	5.086	5.250					

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-10  
IHSS 200: Great Western Reservoir  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of		Detect	Minimum	Maximum	Minimum	Maximum	Arithmetic		Geometric		Standard	Normal	Lognormal
				Detects	Samples						Freq	Nondetect	Nondetect	Detected			
Metals	D	VANADIUM	ug/l	2	15	.133	1.250	1.650	2.700	3.400	1.650	1.572	1.572	.614	1.929	1.914	
Metals	D	ZINC	ug/l	7	15	.467	2.850	5.050	5.800	30.400	9.620	7.060	7.060	8.725	13.587	15.689	
Metals	T	ALUMINUM	ug/l	15	15	1.000			32.200	4260.000	1386.280	936.088	936.088	1123.125	1896.952	4385.439	
Metals	T	ANTIMONY	ug/l	0	15	0.000	7.400	8.250			7.740	7.729	7.729	.431	7.936	7.940	
Metals	T	ARSENIC	ug/l	3	15	.200	.950	1.450	2.400	2.900	1.397	1.298	1.298	.629	1.683	1.686	
Metals	T	BARIIUM	ug/l	15	15	1.000			38.600	57.000	43.673	43.460	43.460	4.660	45.792	45.784	
Metals	T	BERYLLIUM	ug/l	1	15	.067	.150	.200	.400	.400	.183	.176	.176	.065	.213	.208	
Metals	T	CADMIUM	ug/l	1	15	.067	.700	.750	1.900	1.900	.810	.780	.780	.302	.948	.909	
Metals	T	CALCIUM	ug/l	15	15	1.000			17700.000	23200.000	19320.000	19273.364	19273.364	1425.883	19968.332	19969.458	
Metals	T	CESIUM	ug/l	5	15	.333	25.000	25.000	50.000	90.000	36.000	32.757	32.757	18.727	44.515	44.707	
Metals	T	CHROMIUM	ug/l	2	15	.133	1.300	1.850	4.300	4.400	1.853	1.678	1.678	1.043	2.328	2.284	
Metals	T	COBALT	ug/l	3	15	.200	.650	1.150	1.500	2.600	1.100	1.006	1.006	.527	1.340	1.380	
Metals	T	COPPER	ug/l	10	11	.909	.950	.950	4.300	13.400	7.114	6.082	6.082	3.374	8.957	13.289	
Metals	T	CYANIDE	ug/l	0	15	0.000	5.000	5.000			5.000	5.000	5.000		5.000	5.000	
Metals	T	IRON	ug/l	15	15	1.000			40.700	2280.000	974.180	741.336	741.336	596.406	1245.359	2313.953	
Metals	T	LEAD	ug/l	15	15	1.000			1.800	18.500	6.700	5.629	5.629	4.480	8.737	9.556	
Metals	T	LITHIUM	ug/l	15	15	1.000			4.300	8.700	6.447	6.307	6.307	1.368	7.069	7.189	
Metals	T	MAGNESIUM	ug/l	15	15	1.000			3930.000	4600.000	4118.667	4115.371	4115.371	173.653	4197.624	4197.305	
Metals	T	MANGANESE	ug/l	15	15	1.000			6.800	175.000	44.980	35.898	35.898	38.502	62.487	69.049	
Metals	T	MERCURY	ug/l	0	15	0.000	.050	.100			.083	.079	.079	.024	.094	.100	
Metals	T	MOLYBDENUM	ug/l	15	15	1.000			3.600	8.200	5.500	5.375	5.375	1.236	6.062	6.135	
Metals	T	NICKEL	ug/l	6	15	.400	1.300	3.000	2.700	6.500	2.887	2.593	2.593	1.392	3.520	3.818	
Metals	T	POTASSIUM	ug/l	15	15	1.000			1560.000	2030.000	1734.667	1727.988	1727.988	160.973	1807.859	1809.310	
Metals	T	SELENIUM	ug/l	0	15	0.000	1.450	1.900			1.663	1.655	1.655	.171	1.741	1.747	
Metals	T	SILICON	ug/l	15	15	1.000			544.000	3520.000	1625.200	1382.734	1382.734	917.988	2042.599	2364.125	
Metals	T	SILVER	ug/l	0	15	0.000	1.150	1.800			1.540	1.505	1.505	.330	1.690	1.725	

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-10  
IHSS 200: Great Western Reservoir  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of		Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric		Standard Deviation	Normal		Lognormal
				Detects	Samples					Mean	95% UCL (1)		95% UCL (2) *		
Metals	T	SODIUM	ug/l	15	1,000	7590.000	9310.000	8186.667	8174.222	473.855	8402.123	8404.547			
Metals	T	STRONTIUM	ug/l	15	1,000	123.000	146.000	134.267	133.992	8.892	138.310	138.463			
Metals	T	THALLIUM	ug/l	0	0.000	.850	2.150	1.913	1.877	.318	2.058	2.151			
Metals	T	TIN	ug/l	3	.200	3.100	9.700	5.500	5.044	2.322	6.556	7.005			
Metals	T	VANADIUM	ug/l	9	.600	1.250	8.000	3.327	2.695	2.210	4.332	5.137			
Metals	T	ZINC	ug/l	15	1,000	13.800	70.000	32.047	28.877	15.524	39.105	41.732			
Organics	T	ATRAZINE	ug/l	0	0.000	.250	.250	.250	.250	.250	.250	.250			
Organics	T	SIMAZINE	ug/l	0	0.000	.250	.250	.250	.250	.250	.250	.250			
Radionuclides	D	AMERICIUM-241	pci/l	13	1,000	-.003	.018	.004	.021	.006	.006	18.328 *			
Radionuclides	D	PLUTONIUM-239/240	pci/l	9	1,000	-.003	.002	-.000	.117	.002	.001	.830 *			
Radionuclides	D	URANIUM-233/234	pci/l	11	1,000	.140	.560	.412	.387	.128	.482	.548			
Radionuclides	D	URANIUM-235	pci/l	11	1,000	-.081	.510	.079	.371	.174	.174	2.0605e+010 *			
Radionuclides	D	URANIUM-238	pci/l	11	1,000	-.046	.580	.286	.408	.192	.391	4.2271e+008 *			
Radionuclides	T	AMERICIUM-241	pci/l	13	1,000	-.005	.017	.006	.013	.006	.008	2.874 *			
Radionuclides	T	PLUTONIUM-239/240	pci/l	10	1,000	0.000	.005	.003	.006	.001	.004	.245 *			
Radionuclides	T	TRITIUM	pci/l	5	1,000	-29.100	144.300	47.776	13.569	83.228	127.131	9.5714e+091 *			
Radionuclides	T	URANIUM-233/234	pci/l	10	1,000	.190	1.100	.567	.508	.276	.726	.840			
Radionuclides	T	URANIUM-235	pci/l	10	1,000	-.039	.410	.093	.295	.134	.171	6.6237e+011 *			
Radionuclides	T	URANIUM-238	pci/l	10	1,000	-.024	.680	.368	.437	.176	.470	713146.635 *			

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- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.
- (\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-11  
IHSS 200: Great Western Reservoir  
Stream Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum	Minimum Detected		Maximum Detected	Arithmetic Mean		Geometric Mean		Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
							Nondetect	Detect		Nondetect	Detect		Mean	Mean					
Metals	D	ALUMINIUM	ug/l	1	1	1,000				739,000	739,000	739,000	739,000	739,000	739,000				
Metals	D	ANTIMONY	ug/l	0	1	0,000	8,250	8,250					8,250	8,250	8,250				
Metals	D	ARSENIC	ug/l	0	1	0,000	1,300	1,300					1,300	1,300	1,300				
Metals	D	BARIUM	ug/l	1	1	1,000				20,700	20,700	20,700	20,700	20,700	20,700				
Metals	D	BERYLLIUM	ug/l	0	1	0,000	.200	.200					.200	.200	.200				
Metals	D	CADMIUM	ug/l	0	1	0,000	.700	.700					.700	.700	.700				
Metals	D	CALCIUM	ug/l	1	1	1,000				13900,000	13900,000	13900,000	13900,000	13900,000	13900,000				
Metals	D	CESIUM	ug/l	0	1	0,000	25,000	25,000					25,000	25,000	25,000				
Metals	D	CHROMIUM	ug/l	0	1	0,000	1,850	1,850					1,850	1,850	1,850				
Metals	D	COBALT	ug/l	0	1	0,000	1,150	1,150					1,150	1,150	1,150				
Metals	D	COPPER	ug/l	1	1	1,000				5,500	5,500	5,500	5,500	5,500	5,500				
Metals	D	IRON	ug/l	1	1	1,000				119,000	119,000	119,000	119,000	119,000	119,000				
Metals	D	LEAD	ug/l	1	1	1,000				3,600	3,600	3,600	3,600	3,600	3,600				
Metals	D	LITHIUM	ug/l	1	1	1,000				5,800	5,800	5,800	5,800	5,800	5,800				
Metals	D	MAGNESIUM	ug/l	1	1	1,000				3080,000	3080,000	3080,000	3080,000	3080,000	3080,000				
Metals	D	MANGANESE	ug/l	1	1	1,000				63,100	63,100	63,100	63,100	63,100	63,100				
Metals	D	MERCURY	ug/l	0	1	0,000	.100	.100					.100	.100	.100				
Metals	D	MOLYBDENUM	ug/l	1	1	1,000				3,400	3,400	3,400	3,400	3,400	3,400				
Metals	D	NICKEL	ug/l	0	1	0,000	3,000	3,000					3,000	3,000	3,000				
Metals	D	POTASSIUM	ug/l	1	1	1,000				1130,000	1130,000	1130,000	1130,000	1130,000	1130,000				
Metals	D	SELENIUM	ug/l	0	1	0,000	1,850	1,850					1,850	1,850	1,850				
Metals	D	SILICON	ug/l	1	1	1,000				3100,000	3100,000	3100,000	3100,000	3100,000	3100,000				
Metals	D	SILVER	ug/l	1	1	1,000				3,800	3,800	3,800	3,800	3,800	3,800				
Metals	D	SODIUM	ug/l	1	1	1,000				5370,000	5370,000	5370,000	5370,000	5370,000	5370,000				
Metals	D	STRONTIUM	ug/l	1	1	1,000				96,200	96,200	96,200	96,200	96,200	96,200				
Metals	D	THALLIUM	ug/l	0	1	0,000	.450	.450					.450	.450	.450				
Metals	D	TIN	ug/l	0	1	0,000	6,250	6,250					6,250	6,250	6,250				

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(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

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IHSS 200: Great Western Reservoir  
Stream Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
							Nondetect	Detect	Nondetect	Detect						
Metals	D	VANADIUM	ug/l	0	1	0.000	1.650	1.650	1.650	1.650	25.800	1.650	1.650	2324.077	12908.220	
Metals	D	ZINC	ug/l	1	1	1.000	25.800	25.800	25.800	25.800	25.800	25.800	25.800	10.458	10.666	
Metals	T	ALUMINUM	ug/l	4	4	1.000	433.000	1990.000	1463.250	1254.133	731.685	731.685	731.685	10.458	10.666	
Metals	T	ANTIMONY	ug/l	0	4	0.000	8.250	9.900	9.488	9.459	.825	.825	.825	1.403	1.731	
Metals	T	ARSENIC	ug/l	3	4	.750	1.300	1.300	1.050	1.016	.300	.300	.300	71.669	133.725	
Metals	T	BARIIUM	ug/l	4	4	1.000	27.000	80.100	40.925	36.271	26.132	26.132	26.132	.334	.370	
Metals	T	BERYLLIUM	ug/l	0	4	0.000	.200	.300	.275	.271	.050	.050	.050	2.988	10.773	
Metals	T	CADMIUM	ug/l	2	4	.500	.700	1.150	1.788	1.541	1.020	1.020	1.020	326.106	43554.944	
Metals	T	CALCIUM	ug/l	4	4	1.000	11000.000	47200.000	20750.000	16802.265	17650.401	17650.401	17650.401	5.000	5.000	
Metals	T	CESIUM	ug/l	0	4	0.000	25.000	250.000	193.750	140.585	112.500	112.500	112.500	1.713	2.012	
Metals	T	CHROMIUM	ug/l	0	4	0.000	1.000	1.850	1.213	1.166	.425	.425	.425	1.418	1.439	
Metals	T	COBALT	ug/l	0	4	0.000	1.150	1.350	1.300	1.297	.100	.100	.100	26.119	58738.279	
Metals	T	COPPER	ug/l	3	4	.750	1.150	1.150	15.113	9.700	9.356	9.356	9.356	5.000	5.000	
Metals	T	CYANIDE	ug/l	0	4	0.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	2617.623	17721.695	
Metals	T	IRON	ug/l	4	4	1.000	453.000	2340.000	1643.250	1393.300	828.196	828.196	828.196	14.158	4559.767	
Metals	T	LEAD	ug/l	4	4	1.000	.900	11.000	8.325	5.801	4.958	4.958	4.958	9.284	26.590	
Metals	T	LITHIUM	ug/l	3	3	1.000	3.500	7.500	5.800	5.518	2.066	2.066	2.066	9812.104	26642.679	
Metals	T	MAGNESIUM	ug/l	4	4	1.000	2940.000	11100.000	5115.000	4281.722	3992.439	3992.439	3992.439	231.457	324.054	
Metals	T	MANGANESE	ug/l	4	4	1.000	97.000	210.000	171.000	163.842	51.387	51.387	51.387	.100	.100	
Metals	T	MERCURY	ug/l	0	4	0.000	.100	.100	.100	.100	.100	.100	.100	5.901	18.708	
Metals	T	MOLYBDENUM	ug/l	2	4	.500	1.750	1.750	3.500	3.028	2.041	2.041	2.041	6.479	8.361	
Metals	T	NICKEL	ug/l	0	4	0.000	3.000	5.600	4.950	4.791	1.300	1.300	1.300	5825.664	18309.895	
Metals	T	POTASSIUM	ug/l	4	4	1.000	1340.000	6390.000	3237.500	2753.779	2199.884	2199.884	2199.884	1.615	7.843	
Metals	T	SELENIUM	ug/l	0	4	0.000	.400	1.850	.763	.587	.725	.725	.725	8461.923	13915.516	
Metals	T	SILICON	ug/l	4	4	1.000	3460.000	7770.000	5637.500	5239.644	2400.700	2400.700	2400.700	1.134	1.137	
Metals	T	SILVER	ug/l	0	4	0.000	1.050	1.150	1.075	1.074	.050	.050	.050			

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "u" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-11  
IHSS 200: Great Western Reservoir  
Stream Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Maximum Detected	Arithmetic Mean		Geometric Mean		Standard Deviation	Normal 95% UCL		Lognormal 95% UCL (2) *
							Nondetect	Detected	Nondetect	Detected		Mean	Mean	Mean	Mean				
Metals	T	SODIUM	ug/l	4	4	1,000		4610.000	40000.000	40000.000	13717.500	8345.253	17523.655	34334.080	966862.076				
Metals	T	STRONTIUM	ug/l	4	4	1,000		77.900	306.000	306.000	140.875	117.629	110.324	270.672	756.883				
Metals	T	THALLIUM	ug/l	0	4	0,000	.450		.900		.788		.225	1.052	1.451				
Metals	T	TIN	ug/l	0	4	0,000	4,700	6,250			5.088	5.047	.775	5.999	6.169				
Metals	T	VANADIUM	ug/l	1	4	.250	1,650	1,750			2.488	2.219	1.542	4.302	7.699				
Metals	T	ZINC	ug/l	4	4	1,000		15.000	158.000	158.000	110.000	80.410	65.315	186.843	19387.147				
Organics	T	AMETRYN	ug/l	0	3	0,000	.305	.310			.308	.308	.003	.313	.313				
Organics	T	ATRATON	ug/l	0	3	0,000	.255	.310			.292	.290	.032	.345	.366				
Organics	T	ATRAZINE	ug/l	0	4	0,000	.250	.260			.255	.255	.004	.260	.260				
Organics	T	PROMETON	ug/l	0	3	0,000	.155	.155			.155	.155	.000	.155	.155				
Organics	T	PROMETRYN	ug/l	0	3	0,000	.305	.310			.308	.308	.003	.313	.313				
Organics	T	PROPACINE	ug/l	0	3	0,000	.155	.155			.155	.155	.000	.155	.155				
Organics	T	SIMAZINE	ug/l	0	4	0,000	.250	.310			.294	.293	.029	.328	.337				
Organics	T	SIMETRYN	ug/l	0	3	0,000	.355	.365			.360	.360	.005	.368	.369				
Organics	T	TERBUTHYLAZINE	ug/l	0	3	0,000	.155	.155			.155	.155	.000	.155	.155				
Organics	T	TERBUTRYN	ug/l	0	3	0,000	.255	.265			.262	.262	.006	.271	.272				
Radionuclides	D	AMERICIUM-241	pCi/l	1	1	1,000		.003	.003		.003	.003							
Radionuclides	D	URANIUM-233/234	pCi/l	1	1	1,000		.480	.480		.480	.480							
Radionuclides	D	URANIUM-235	pCi/l	1	1	1,000		0.000	0.000		0.000	1.000			*				
Radionuclides	D	URANIUM-238	pCi/l	1	1	1,000		.410	.410		.410	.410							
Radionuclides	T	AMERICIUM-241	pCi/l	3	3	1,000		-.001	.007		.004	.035	.004	.011	1.0960e+056 *				
Radionuclides	T	PLUTONIUM-239/240	pCi/l	3	3	1,000		-.001	.001		0.000	.100	.001	.002	3.8851e+025 *				
Radionuclides	T	URANIUM-233/234	pCi/l	2	2	1,000		.440	1.200		.820	.727	.537	3.219					
Radionuclides	T	URANIUM-235	pCi/l	2	2	1,000		0.000	.050		.025	.224	.035	.183	*				

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-11  
 IHSS 200: Great Western Reservoir  
 Stream Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Radionuclides	T	URANIUM-238	pCi/l	2	2	1.000			.650	.870	.760	.752	.156	1.455	1.455

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-12  
IHSS 201: Standley Lake  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	D	ALUMINIUM	ug/l	11	15	.733	7.350	8.650	16.400	431.000	48.600	22.636	106.321	96.943	77.499
Metals	D	ANTIMONY	ug/l	0	16	0.000	7.400	8.250			7.772	7.761	.435	7.963	7.968
Metals	D	ARSENIC	ug/l	1	16	.063	.950	1.600	2.900	2.900	1.363	1.301	.485	1.575	1.572
Metals	D	BARIUM	ug/l	16	16	1.000			32.500	37.600	35.469	35.430	1.695	36.211	36.242
Metals	D	BERYLLIUM	ug/l	0	16	0.000	.150	.200			.172	.170	.026	.183	.184
Metals	D	CADMIUM	ug/l	1	16	.063	.700	.750	2.500	2.500	.841	.788	.443	1.035	.961
Metals	D	CALCIUM	ug/l	16	16	1.000			21900.000	26900.000	23406.250	23384.290	1078.560	23878.929	23869.580
Metals	D	CESIUM	ug/l	5	16	.313	25.000	25.000	50.000	80.000	35.938	32.709	17.909	43.786	44.406
Metals	D	CHROMIUM	ug/l	1	16	.063	1.300	1.850	3.800	3.800	1.697	1.622	.624	1.970	1.941
Metals	D	COBALT	ug/l	0	16	0.000	.650	1.150			.869	.834	.256	.981	1.002
Metals	D	COPPER	ug/l	5	16	.313	.950	1.200	1.900	2.600	1.409	1.330	.529	1.641	1.668
Metals	D	IRON	ug/l	10	13	.769	8.150	8.150	11.000	40.300	22.588	19.163	12.201	28.619	35.238
Metals	D	LEAD	ug/l	7	16	.438	.500	1.100	2.100	8.000	2.094	1.608	1.865	2.911	3.149
Metals	D	LITHIUM	ug/l	16	16	1.000			6.300	9.000	7.488	7.440	.872	7.870	7.893
Metals	D	MAGNESIUM	ug/l	16	16	1.000			5080.000	6110.000	5383.125	5378.762	229.774	5483.824	5482.180
Metals	D	MANGANESE	ug/l	12	16	.750	.450	.450	1.600	1570.000	129.813	5.684	394.914	302.883	3188.134
Metals	D	MERCURY	ug/l	0	16	0.000	.050	.100			.084	.081	.024	.095	.100
Metals	D	MOLYBDENUM	ug/l	16	16	1.000			2.700	8.800	5.131	4.944	1.473	5.777	5.888
Metals	D	NICKEL	ug/l	3	16	.188	1.300	3.000	2.800	3.400	2.369	2.196	.863	2.747	2.973
Metals	D	POTASSIUM	ug/l	16	16	1.000			1710.000	2050.000	1856.250	1854.887	73.926	1888.648	1889.101
Metals	D	SELENIUM	ug/l	2	16	.125	1.400	1.950	3.000	3.800	1.944	1.872	.626	2.218	2.205
Metals	D	SILICON	ug/l	16	16	1.000			865.000	2440.000	1352.375	1297.734	414.076	1533.844	1561.406
Metals	D	SILVER	ug/l	0	12	0.000	1.150	1.800			1.421	1.386	.335	1.594	1.621
Metals	D	SODIUM	ug/l	16	16	1.000			11200.000	13400.000	11900.000	11891.192	483.046	12111.695	12109.643
Metals	D	STRONTIUM	ug/l	16	16	1.000			152.000	179.000	160.688	160.558	6.780	163.659	163.656
Metals	D	THALLIUM	ug/l	0	16	0.000	.450	.800			.663	.654	.106	.709	.718
Metals	D	TIN	ug/l	5	15	.333	3.100	6.250	6.300	13.700	7.110	6.429	3.286	8.604	9.290

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this station only.) The actual meaning of this result is questionable.

Table C-12  
IHSS 201: Standley Lake  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal		Lognormal
							Nondetect	Detect	Nondetect	Detect						95% UCL (1)	95% UCL (2) *	
Metals	D	VANADIUM	ug/l	0	16	0.000	1.250	1.650	1.425	1.411	19.500	1.425	1.411	.205	1.515	1.521		
Metals	D	ZINC	ug/l	10	16	.625	2.850	5.050	9.575	8.382	7.000	9.575	8.382	4.859	11.704	13.162		
Metals	T	ALUMINUM	ug/l	16	16	1.000			349.956	239.381	65.200	1540.000	239.381	370.687	512.410	619.339		
Metals	T	ANTIMONY	ug/l	0	16	0.000	7.400	8.250	7.772	7.761			7.761	.435	7.963	7.968		
Metals	T	ARSENIC	ug/l	0	16	0.000	1.100	1.600	1.453	1.441			1.441	.189	1.536	1.549		
Metals	T	BARIUM	ug/l	16	16	1.000			36.175	36.054	31.000	44.500	36.054	3.126	37.545	37.560		
Metals	T	BERYLLIUM	ug/l	0	16	0.000	.150	.200	.172	.170			.170	.026	.183	.184		
Metals	T	CADMIUM	ug/l	0	16	0.000	.700	.750	.728	.728			.728	.026	.739	.740		
Metals	T	CALCIUM	ug/l	16	16	1.000			22187.500	21972.484	12600.000	26100.000	21972.484	2775.818	23404.002	23874.953		
Metals	T	CESIUM	ug/l	0	16	0.000	25.000	25.000	25.000	25.000			25.000		25.000	25.000		
Metals	T	CHROMIUM	ug/l	1	16	.063	1.300	1.850	1.634	1.592	2.800	2.800	1.592	.415	1.816	1.823		
Metals	T	COBALT	ug/l	2	16	.125	.650	1.150	.988	.932	1.300	1.900	.932	.357	1.144	1.177		
Metals	T	COPPER	ug/l	12	13	.923	.950	.950	4.142	3.733	2.800	7.100	3.733	1.751	5.008	5.892		
Metals	T	CYANIDE	ug/l	1	16	.063	5.000	5.000	6.031	5.477	21.500	21.500	5.477	4.125	7.839	7.016		
Metals	T	IRON	ug/l	16	16	1.000			303.325	216.425	37.700	1150.000	216.425	282.378	427.077	539.570		
Metals	T	LEAD	ug/l	13	16	.813	1.000	1.350	3.559	2.983	2.500	9.900	2.983	2.356	4.592	5.086		
Metals	T	LITHIUM	ug/l	16	16	1.000			7.500	7.369	4.900	9.500	7.369	1.404	8.115	8.236		
Metals	T	MAGNESIUM	ug/l	16	16	1.000			5302.500	5297.058	5040.000	6110.000	5297.058	255.930	5414.661	5412.293		
Metals	T	MANGANESE	ug/l	16	16	1.000			153.238	28.059	5.500	1580.000	28.059	400.360	328.695	438.492		
Metals	T	MERCURY	ug/l	1	16	.063	.050	.100	.133	.096	.820	.820	.096	.185	.213	.172		
Metals	T	MOLYBDENUM	ug/l	16	16	1.000			5.225	5.076	3.300	7.700	5.076	1.293	5.792	5.896		
Metals	T	NICKEL	ug/l	4	16	.250	1.300	3.000	4.594	2.859	3.100	33.100	2.859	7.690	7.964	6.531		
Metals	T	POTASSIUM	ug/l	16	16	1.000			1895.625	1891.087	1750.000	2250.000	1891.087	139.903	1956.938	1956.318		
Metals	T	SELENIUM	ug/l	1	16	.063	1.400	1.950	2.097	2.003	5.300	5.300	2.003	.865	2.476	2.367		
Metals	T	SILICON	ug/l	16	16	1.000			1406.938	1342.150	957.000	2620.000	1342.150	485.589	1619.747	1629.552		
Metals	T	SILVER	ug/l	0	12	0.000	1.150	1.800	1.421	1.386			1.386	.335	1.594	1.621		

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.0001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-12  
IHSS 201: Standley Lake  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of		Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal		Lognormal
				Detects	Samples						Mean	Mean	Mean	95% UCL (1)		95% UCL (2)		
Metals	T	SODIUM	ug/l	16	16	1.000			11200.000	415000.000	36856.250	14551.629	100839.311	81049.078	39067.257			
Metals	T	STRONTIUM	ug/l	16	16	1.000			146.000	174.000	156.688	156.536	7.199	159.843	159.865			
Metals	T	THALLIUM	ug/l	0	16	0.000	.450	.800			.663	.654	.106	.709	.718			
Metals	T	TIN	ug/l	0	16	0.000	3.100	6.250			4.478	4.213	1.614	5.185	5.369			
Metals	T	VANADIUM	ug/l	0	16	0.000	1.250	1.650			1.425	1.411	.205	1.515	1.521			
Metals	T	ZINC	ug/l	13	16	.813	5.050	5.050	12.800	184.000	29.959	18.673	42.838	48.733	51.921			
Organics	T	ATRAZINE	ug/l	0	16	0.000	.250	.250			.250	.250		.250	.250			
Organics	T	SIMAZINE	ug/l	0	16	0.000	.250	.250			.250	.250		.250	.250			
Radionuclides	D	AMERICIUM-241	pCi/l	12	12	1.000			- .004	.013	.004	.033	.005	.007	162.633 *			
Radionuclides	D	PLUTONIUM-239/240	pCi/l	11	11	1.000			- .002	.009	.002	.021	.003	.003	8.663 *			
Radionuclides	D	URANIUM-233/234	pCi/l	11	11	1.000			.430	1.200	.765	.735	.222	.886	.924			
Radionuclides	D	URANIUM-235	pCi/l	11	11	1.000			- .004	.710	.157	.164	.267	.303	3.8150e+008 *			
Radionuclides	D	URANIUM-238	pCi/l	11	11	1.000			- .043	.730	.410	.557	.248	.546	2.9102e+009 *			
Radionuclides	T	AMERICIUM-241	pCi/l	15	15	1.000			- .001	.026	.007	.011	.007	.010	1.108 *			
Radionuclides	T	PLUTONIUM-239/240	pCi/l	15	15	1.000			0.000	.009	.003	.008	.002	.004	.414 *			
Radionuclides	T	URANIUM-233/234	pCi/l	16	16	1.000			.390	1.300	.779	.734	.286	.904	.930			
Radionuclides	T	URANIUM-235	pCi/l	16	16	1.000			- .021	.270	.061	.121	.073	.093	89675.883 *			
Radionuclides	T	URANIUM-238	pCi/l	16	16	1.000			.290	1.100	.671	.622	.262	.786	.833			

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "##" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-13  
IHSS 201: Standley Lake  
Stream Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	D	ALUMINUM	ug/l	1	2	.500	8.650	8.650	455.000	455.000	231.825	62.736	315.617	1640.952	
Metals	D	ANTIMONY	ug/l	0	1	0.000	8.250	8.250			8.250	8.250			
Metals	D	ARSENIC	ug/l	0	2	0.000	1.300	1.300			1.300	1.300			1.300
Metals	D	BARIUM	ug/l	2	2	1.000			21.400	43.100	32.250	30.370	15.344	100.757	
Metals	D	BERYLLIUM	ug/l	0	2	0.000	.200	.200			.200	.200			.200
Metals	D	CADMIUM	ug/l	1	2	.500	.700	.700	2.500	2.500	1.600	1.323	1.273	7.283	
Metals	D	CALCIUM	ug/l	2	2	1.000			14600.000	27200.000	20900.000	19927.870	8909.545	60678.200	
Metals	D	CESIUM	ug/l	0	2	0.000	25.000	25.000			25.000	25.000			25.000
Metals	D	CHROMIUM	ug/l	0	2	0.000	1.850	1.850			1.850	1.850			1.850
Metals	D	COBALT	ug/l	0	2	0.000	1.150	1.150			1.150	1.150			1.150
Metals	D	COPPER	ug/l	1	2	.500	1.200	1.200	8.100	8.100	4.650	3.118	4.879	26.433	
Metals	D	IRON	ug/l	2	2	1.000			19.800	228.000	123.900	67.189	147.220	781.187	
Metals	D	LEAD	ug/l	2	2	1.000			4.000	10.200	7.100	6.387	4.384	26.673	
Metals	D	LITHIUM	ug/l	2	2	1.000			5.900	12.000	8.950	8.414	4.313	28.208	
Metals	D	MAGNESIUM	ug/l	2	2	1.000			3520.000	6310.000	4915.000	4712.876	1972.828	13723.030	
Metals	D	MANGANESE	ug/l	2	2	1.000			4.800	58.100	31.450	16.700	37.689	199.718	
Metals	D	MERCURY	ug/l	0	2	0.000	.100	.100			.100	.100			.100
Metals	D	MOLYBDENUM	ug/l	2	2	1.000			4.300	6.600	5.450	5.327	1.626	12.711	
Metals	D	NICKEL	ug/l	0	2	0.000	3.000	3.000			3.000	3.000			3.000
Metals	D	POTASSIUM	ug/l	2	2	1.000			1580.000	2170.000	1875.000	1851.648	417.193	3737.630	
Metals	D	SELENIUM	ug/l	1	2	.500	1.850	1.850	3.900	3.900	2.875	2.686	1.450	9.347	
Metals	D	SILICON	ug/l	2	2	1.000			1240.000	3390.000	2315.000	2050.268	1520.280	9102.550	
Metals	D	SILVER	ug/l	0	2	0.000	1.150	1.150			1.150	1.150			1.150
Metals	D	SODIUM	ug/l	2	2	1.000			7270.000	14200.000	10735.000	10160.413	4900.250	32613.010	
Metals	D	STRONTIUM	ug/l	2	2	1.000			102.000	189.000	145.500	138.845	61.518	420.159	
Metals	D	THALLIUM	ug/l	0	2	0.000	.450	.450			.450	.450			.450
Metals	D	TIN	ug/l	0	2	0.000	6.250	6.250			6.250	6.250			6.250

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.  
 (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\* ) A "" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-13  
IHSS 201: Standley Lake  
Stream Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	D	VANADIUM	ug/l	0	2	0.000	1.650	1.650	13.300	44.900	1.650	1.650	22.345	1.650	
Metals	D	ZINC	ug/l	2	2	1.000					29.100	24.437		128.861	
Metals	T	ALUMINUM	ug/l	4	4	1.000			344.000	769.000	622.500	594.804	191.030	847.246	1222.891
Metals	T	ANTIMONY	ug/l	0	4	0.000	7.400	8.250			7.825	7.813	.491	8.402	8.463
Metals	T	ARSENIC	ug/l	0	4	0.000	1.300	1.600			1.450	1.442	.173	1.654	1.699
Metals	T	BARIIUM	ug/l	4	4	1.000			25.400	43.400	34.750	33.886	8.841	45.151	52.259
Metals	T	BERYLLIUM	ug/l	1	4	.250	.150	.200	.360	.360	.228	.216	.091	.335	.440
Metals	T	CADMIUM	ug/l	1	4	.250	.700	.750	2.400	2.400	1.150	.986	.834	2.131	4.922
Metals	T	CALCIUM	ug/l	4	4	1.000			13400.000	26000.000	21675.000	21007.597	5644.688	28315.975	35879.911
Metals	T	CESIUM	ug/l	0	4	0.000	25.000	25.000			25.000	25.000		25.000	
Metals	T	CHROMIUM	ug/l	1	4	.250	1.300	1.850	2.900	2.900	1.975	1.895	.669	2.762	3.458
Metals	T	COBALT	ug/l	0	4	0.000	.650	1.150			.900	.865	.289	1.240	1.580
Metals	T	COPPER	ug/l	4	4	1.000			5.800	16.500	11.375	10.285	5.560	17.916	38.144
Metals	T	CYANIDE	ug/l	0	4	0.000	5.000	5.000			5.000	5.000		5.000	
Metals	T	IRON	ug/l	4	4	1.000			642.000	1100.000	794.500	776.434	208.239	1039.494	1143.630
Metals	T	LEAD	ug/l	4	4	1.000			3.500	10.700	7.450	6.909	2.968	10.942	20.549
Metals	T	LITHIUM	ug/l	4	4	1.000			5.500	11.100	8.600	8.330	2.364	11.381	14.135
Metals	T	MAGNESIUM	ug/l	4	4	1.000			3450.000	6480.000	5480.000	5323.483	1376.299	7099.216	8830.223
Metals	T	MANGANESE	ug/l	4	4	1.000			111.000	307.000	167.000	151.553	94.078	277.683	455.800
Metals	T	MERCURY	ug/l	2	4	.500	.100	.100	.120	.120	.110	.110	.012	.124	.126
Metals	T	MOLYBDENUM	ug/l	4	4	1.000			3.500	7.400	5.550	5.332	1.741	7.598	9.871
Metals	T	NICKEL	ug/l	1	4	.250	1.300	3.000	2.800	2.800	2.525	2.392	.822	3.492	5.538
Metals	T	POTASSIUM	ug/l	4	4	1.000			1260.000	2370.000	1985.000	1929.446	495.883	2568.406	3172.129
Metals	T	SELENIUM	ug/l	0	4	0.000	1.850	1.950			1.900	1.899	.058	1.968	1.971
Metals	T	SILICON	ug/l	4	4	1.000			928.000	4040.000	2557.000	2166.517	1521.445	4346.980	19195.384
Metals	T	SILVER	ug/l	0	4	0.000	1.150	1.800			1.475	1.439	.375	1.917	2.206

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-13  
IHSS 201: Standley Lake  
Stream Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
											Mean	Mean	Mean	Mean			
Metals	T	SODIUM	ug/l	4	4	1,000			6940.000	13600.000	11257.753	3170.237	15389.783	20267.512			
Metals	T	STRONTIUM	ug/l	4	4	1,000			98.400	186.000	155.396	41.469	209.138	266.521			
Metals	T	THALLIUM	ug/l	0	4	0.000	.450	.650			.541	.115	.686	.751			
Metals	T	TIN	ug/l	0	4	0.000	3.100	6.250			4.402	1.819	6.815	10.085			
Metals	T	VANADIUM	ug/l	1	4	.250	1.250	1.650	3.800	3.800	1.896	1.157	3.449	5.734			
Metals	T	ZINC	ug/l	4	4	1,000			22.700	143.000	56.587	55.818	138.820	1409.718			
Organics	T	ATRAZINE	ug/l	0	4	0.000	.250	.250			.250		.250				
Organics	T	SIMAZINE	ug/l	0	4	0.000	.250	.250			.250		.250				
Radionuclides	D	AMERICIUM-241	pCi/l	2	2	1,000			-.002	.001	.032	.002	.009	*			
Radionuclides	D	PLUTONIUM-239/240	pCi/l	2	2	1,000			.004	.006	.005	.001	.011				
Radionuclides	D	URANIUM-233/234	pCi/l	1	1	1,000			.480	.480	.480						
Radionuclides	D	URANIUM-235	pCi/l	1	1	1,000			.031	.031	.031						
Radionuclides	D	URANIUM-238	pCi/l	1	1	1,000			.380	.380	.380						
Radionuclides	T	AMERICIUM-241	pCi/l	2	2	1,000			.004	.004	.004	.000	.005				
Radionuclides	T	PLUTONIUM-239/240	pCi/l	4	4	1,000			0.000	.001	.032	.001	.001	1.3267e+009 *			
Radionuclides	T	URANIUM-233/234	pCi/l	4	4	1,000			.078	1.273	.629	.600	1.335	1182.323			
Radionuclides	T	URANIUM-235	pCi/l	4	4	1,000			0.000	.170	.234	.076	.198	4.2850e+040 *			
Radionuclides	T	URANIUM-238	pCi/l	4	4	1,000			-.022	.828	.609	.348	.816	1.9666e+053 *			

NOTES: Source table for summary statistics was DA091994.db.

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(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\* ) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-14  
IHSS 202: Mower Reservoir  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *	
Metals	D	ALUMINUM	ug/l	5	13	.385	7.350	8.650	17.500	47.800	16.346	12.456	14.606	23.565	26.053
Metals	D	ANTIMONY	ug/l	0	13	0.000	7.400	8.250			7.727	7.716	.430	7.940	7.944
Metals	D	ARSENIC	ug/l	13	13	1.000			2.900	6.300	4.138	4.037	.990	4.628	4.684
Metals	D	BARIUM	ug/l	13	13	1.000			20.300	31.400	24.692	24.496	3.314	26.330	26.420
Metals	D	BERYLLIUM	ug/l	0	13	0.000	.150	.200			.169	.168	.025	.182	.183
Metals	D	CADMIUM	ug/l	1	13	.077	.700	.750	1.800	1.800	.815	.785	.297	.962	.928
Metals	D	CALCIUM	ug/l	13	13	1.000			11200.000	14200.000	12792.308	12753.505	1028.317	13300.541	13334.414
Metals	D	CESIUM	ug/l	4	13	.308	25.000	25.000	50.000	80.000	36.538	32.924	19.513	46.183	47.367
Metals	D	CHROMIUM	ug/l	1	13	.077	1.300	1.850	3.400	3.400	1.673	1.603	.585	1.962	1.952
Metals	D	COBALT	ug/l	1	13	.077	.650	1.150	1.800	1.800	.931	.875	.359	1.108	1.140
Metals	D	COPPER	ug/l	5	12	.417	.950	1.200	2.100	4.500	1.938	1.661	1.192	2.555	2.835
Metals	D	IRON	ug/l	13	13	1.000			7.000	71.100	35.462	28.110	22.085	46.377	65.106
Metals	D	LEAD	ug/l	12	13	.923	.950	.950	2.100	11.400	4.204	3.537	2.721	5.549	6.416
Metals	D	LITHIUM	ug/l	13	13	1.000			6.500	10.600	8.223	8.127	1.340	8.886	8.931
Metals	D	MAGNESIUM	ug/l	13	13	1.000			5930.000	7160.000	6627.692	6613.271	452.588	6851.378	6863.005
Metals	D	MANGANESE	ug/l	13	13	1.000			2.700	7.900	4.854	4.566	1.733	5.710	6.027
Metals	D	MERCURY	ug/l	2	13	.154	.050	.100	.200	.200	.096	.085	.052	.122	.131
Metals	D	MOLYBDENUM	ug/l	2	13	.154	.850	1.350	2.700	3.100	1.358	1.226	.729	1.718	1.754
Metals	D	NICKEL	ug/l	2	13	.154	1.300	3.000	2.900	6.600	2.485	2.161	1.496	3.224	3.473
Metals	D	POTASSIUM	ug/l	13	13	1.000			141.000	640.000	412.769	355.609	202.770	512.986	633.577
Metals	D	SELENIUM	ug/l	1	13	.077	1.450	1.900	3.000	3.000	1.642	1.606	.426	1.853	1.824
Metals	D	SILICON	ug/l	13	13	1.000			410.000	3330.000	1476.692	1088.876	1154.474	2047.277	2767.857
Metals	D	SILVER	ug/l	0	13	0.000	1.150	1.800			1.550	1.515	.329	1.713	1.755
Metals	D	SODIUM	ug/l	13	13	1.000			27100.000	32500.000	29761.538	29706.339	1875.073	30688.270	30733.847
Metals	D	STRONTIUM	ug/l	13	13	1.000			114.000	137.000	124.615	124.407	7.545	128.344	128.445
Metals	D	THALLIUM	ug/l	0	13	0.000	.450	2.250			1.158	.965	.694	1.501	1.812
Metals	D	TIN	ug/l	1	13	.077	3.100	6.250	8.100	8.100	4.696	4.371	1.859	5.615	5.917

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

# **NOTICE**

**All drawings located at the end of the document.**

Table C-14  
IHSS 202: Mower Reservoir  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Maximum Detected	Arithmetic Mean		Geometric Mean		Standard Deviation	Normal		Lognormal
							Nondetect	Detect	Nondetect	Detect		Mean	Mean	95% UCL (1)	95% UCL (2) *				
Metals	D	VANADIUM	ug/l	6	13	.462	1.250	1.650	2.900	6.100	2.758	2.392	1.588	3.542	3.907				
Metals	D	ZINC	ug/l	8	13	.615	2.850	5.050	5.700	143.000	18.458	8.387	37.803	37.141	36.267				
Metals	T	ALUMINIUM	ug/l	13	13	1.000			25.900	196.000	92.554	78.656	55.663	120.065	138.902				
Metals	T	ANTIMONY	ug/l	0	13	0.000	7.400	8.250			7.727	7.716	.430	7.940	7.944				
Metals	T	ARSENIC	ug/l	13	13	1.000			3.100	6.600	4.915	4.828	.944	5.382	5.479				
Metals	T	BARIIUM	ug/l	13	13	1.000			20.400	34.700	25.977	25.758	3.604	27.758	27.847				
Metals	T	BERYLLIUM	ug/l	0	13	0.000	.150	.200			.169	.168	.025	.182	.183				
Metals	T	CADMIUM	ug/l	2	13	.154	.700	.750	4.000	9.000	1.619	1.011	2.395	2.803	2.530				
Metals	T	CALCIUM	ug/l	13	13	1.000			11100.000	13900.000	12676.923	12650.385	840.787	13092.472	13120.668				
Metals	T	CESIUM	ug/l	3	13	.231	25.000	25.000	50.000	80.000	33.846	30.846	17.930	42.708	42.620				
Metals	T	CHROMIUM	ug/l	1	13	.077	1.300	1.850	65.800	65.800	6.473	2.014	17.828	15.284	8.759				
Metals	T	COBALT	ug/l	0	13	0.000	.650	1.150			.842	.809	.253	.967	.989				
Metals	T	COPPER	ug/l	3	13	.231	.950	1.200	2.200	4.500	1.577	1.351	1.112	2.126	2.139				
Metals	T	CYANIDE	ug/l	0	13	0.000	5.000	5.000			5.000	5.000		5.000	5.000				
Metals	T	IRON	ug/l	13	13	1.000			56.500	328.000	156.692	141.338	75.047	193.784	211.109				
Metals	T	LEAD	ug/l	13	13	1.000			2.400	37.200	7.223	4.745	9.775	12.054	11.516				
Metals	T	LITHIUM	ug/l	13	13	1.000			5.200	9.400	7.292	7.176	1.349	7.959	8.062				
Metals	T	MAGNESIUM	ug/l	13	13	1.000			5820.000	7340.000	6568.462	6544.301	586.740	6858.451	6875.042				
Metals	T	MANGANESE	ug/l	13	13	1.000			11.800	37.000	21.962	20.529	8.282	26.055	27.593				
Metals	T	MERCURY	ug/l	2	13	.154	.050	.100	.200	.300	.104	.088	.072	.139	.148				
Metals	T	MOLYBDENUM	ug/l	5	13	.385	.850	1.350	1.900	4.400	1.777	1.571	1.004	2.273	2.416				
Metals	T	NICKEL	ug/l	4	13	.308	1.300	3.000	2.800	23.000	4.562	2.962	6.019	7.536	7.905				
Metals	T	POTASSIUM	ug/l	13	13	1.000			147.000	740.000	420.308	362.448	211.720	524.948	638.089				
Metals	T	SELENIUM	ug/l	0	13	0.000	1.450	1.900			1.662	1.651	.200	1.760	1.767				
Metals	T	SILICON	ug/l	13	13	1.000			348.000	3250.000	1345.231	956.752	1107.179	1892.441	2681.138				
Metals	T	SILVER	ug/l	0	13	0.000	1.150	1.800			1.550	1.515	.329	1.713	1.755				

NOTES: Source table for summary statistics was DA091994.db.

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T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.0001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-14  
IHSS 202: Mower Reservoir  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL	Lognormal 95% UCL
Metals	T	SODIUM	ug/l	13	13	1.000			27000.000	31200.000	29076.923	29041.301	1494.520	29815.571	29840.954
Metals	T	STRONTIUM	ug/l	13	13	1.000			114.000	132.000	122.692	122.557	6.005	125.660	125.739
Metals	T	THALLIUM	ug/l	0	13	0.000	.450	2.250			1.235	1.005	.766	1.613	2.021
Metals	T	TIN	ug/l	1	13	.077	3.100	6.250	6.500	6.500	4.573	4.298	1.657	5.392	5.666
Metals	T	VANADIUM	ug/l	6	13	.462	1.250	1.650	2.500	6.400	2.604	2.274	1.556	3.373	3.580
Metals	T	ZINC	ug/l	7	13	.538	2.850	5.050	6.600	18.000	8.177	6.560	5.490	10.890	13.618
Organics	T	1,1,1-TRICHLOROETHANE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	1,1,2,2-TETRACHLOROETHANE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	1,1,2-TRICHLOROETHANE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	1,1-DICHLOROETHANE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	1,1-DICHLOROETHENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	1,2-DICHLOROETHANE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	1,2-DICHLOROETHENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	1,2-DICHLOROPROPANE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	2-BUTANONE	ug/l	0	5	0.000	5.000	5.000			5.000	5.000		5.000	
Organics	T	2-HEXANONE	ug/l	0	10	0.000	5.000	5.000			5.000	5.000		5.000	
Organics	T	4-METHYL-2-PENTANONE	ug/l	0	10	0.000	5.000	5.000			5.000	5.000		5.000	
Organics	T	ACETONE	ug/l	0	5	0.000	5.000	5.000			5.000	5.000		5.000	
Organics	T	ATRAZINE	ug/l	0	12	0.000	.250	.250			.250	.250		.250	.250
Organics	T	BENZENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	BROMODICHLOROMETHANE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	BROMOFORM	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	BROMOMETHANE	ug/l	0	10	0.000	5.000	5.000			5.000	5.000		5.000	
Organics	T	CARBON DISULFIDE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	CARBON TETRACHLORIDE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	
Organics	T	CHLOROBENZENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500		2.500	

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-14  
IHSS 202: Mower Reservoir  
Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Organics	T	CHLOROETHANE	ug/l	0	10	0.000	5.000	5.000			5.000	5.000	5.000	5.000	5.000
Organics	T	CHLOROFORM	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	CHLOROMETHANE	ug/l	0	10	0.000	5.000	5.000			5.000	5.000	5.000	5.000	5.000
Organics	T	CIS-1,3-DICHLOROPROPENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	DIBROMOCHLOROMETHANE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	ETHYLBENZENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	METHYLENE CHLORIDE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	STIMAZINE	ug/l	0	12	0.000	.250	.250			.250	.250	.250	.250	.250
Organics	T	STYRENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	TETRACHLOROETHENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	TOLUENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	TOTAL XYLENES	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	TRANS-1,3-DICHLOROPROPENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	TRICHLOROETHENE	ug/l	0	10	0.000	2.500	2.500			2.500	2.500	2.500	2.500	2.500
Organics	T	VINYL ACETATE	ug/l	0	10	0.000	5.000	5.000			5.000	5.000	5.000	5.000	5.000
Organics	T	VINYL CHLORIDE	ug/l	0	10	0.000	5.000	5.000			5.000	5.000	5.000	5.000	5.000
Radionuclides	D	AMERICIUM-241	pci/l	12	12	1.000			-.019	.116	.013	-.015	.034	.030	28.790 *
Radionuclides	D	PLUTONIUM-239/240	pci/l	10	10	1.000			-.001	.003	.001	-.041	.001	.001	3.153 *
Radionuclides	D	URANIUM-233/234	pci/l	10	10	1.000			.170	.699	.350	-.311	.182	.456	-.514
Radionuclides	D	URANIUM-235	pci/l	10	10	1.000			-.198	.140	.020	-.261	.094	.074	7.2431e+009 *
Radionuclides	D	URANIUM-238	pci/l	10	10	1.000			-.255	.420	.135	-.261	.193	.247	5.3251e+008 *
Radionuclides	T	AMERICIUM-241	pci/l	12	12	1.000			0.000	.017	.006	.014	.005	.009	6.959 *
Radionuclides	T	PLUTONIUM-239/240	pci/l	12	12	1.000			-.005	.030	.005	-.016	.010	.010	26.858 *
Radionuclides	T	URANIUM-233/234	pci/l	13	13	1.000			.080	.820	.388	.310	.238	.506	.707
Radionuclides	T	URANIUM-235	pci/l	13	13	1.000			-.028	.145	.032	-.309	.059	.061	5.3205e+007 *

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\* ) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-14  
 IHSS 202: Mower Reservoir  
 Reservoir Surface Water Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum		Maximum		Arithmetic Mean		Geometric Mean		Standard Deviation		Normal 95% UCL		Lognormal 95% UCL	
							Nondetect	Detected	Nondetect	Detected	Mean	Standard Deviation	Mean	Standard Deviation	(1)	(2) *	(1)	(2) *		
Radionuclides	T	URANIUM-238	pCi/l	12	12	1.000					.650	.285	.243	.168	.373	.437				

NOTES: Source table for summary statistics was DA091994.db.  
 Concentration values should be considered significant to only two places.  
 T/D = Total (unfiltered) / Dissolved (filtered).  
 (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.  
 (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.  
 (\*) A "u" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-15  
IHSS 200: Great Western Reservoir  
Groundwater Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	D	ALUMINUM	ug/l	1	8	.125	6.500	20.000	47.100	47.100	16.231	13.199	13.249	25.108	30.390
Metals	D	ANTIMONY	ug/l	2	8	.250	6.500	18.000	17.300	89.800	22.013	14.613	27.836	40.662	56.401
Metals	D	ARSENIC	ug/l	1	8	.125	.500	1.500	1.000	1.000	.813	.744	.372	1.062	1.202
Metals	D	BARIIUM	ug/l	6	8	.750	8.000	11.500	24.200	55.000	28.838	24.657	15.310	39.095	57.651
Metals	D	BERYLLIUM	ug/l	0	8	0.000	.500	.500	.500	.500	.500	.500	.500	.500	.500
Metals	D	CADMIUM	ug/l	0	8	0.000	1.000	2.000	2.000	2.000	1.438	1.384	.417	1.717	1.817
Metals	D	CALCIUM	ug/l	8	8	1.000	6.000	18.000	267000.000	357000.000	313375.000	312372.064	26597.194	331194.686	332831.235
Metals	D	CESIUM	ug/l	2	5	.400	6.000	18.000	26.000	38.000	20.500	17.295	12.135	32.070	78.467
Metals	D	CHROMIUM	ug/l	0	8	0.000	1.000	2.000	2.000	2.000	1.625	1.588	.354	1.862	1.947
Metals	D	COBALT	ug/l	0	8	0.000	1.500	3.000	3.000	3.000	2.063	1.997	.563	2.440	2.547
Metals	D	COPPER	ug/l	2	8	.250	1.000	2.000	3.000	3.800	1.850	1.612	1.073	2.569	3.122
Metals	D	IRON	ug/l	6	7	.857	1.600	1.600	50.900	464.000	262.071	121.682	179.968	394.237	330487.195
Metals	D	LEAD	ug/l	1	8	.125	.500	1.000	2.600	2.600	.888	.731	.728	1.375	1.557
Metals	D	LITHIUM	ug/l	8	8	1.000	1.000	346.000	346.000	483.000	420.375	417.757	49.814	453.749	457.955
Metals	D	MAGNESIUM	ug/l	8	8	1.000	1.000	51200.000	88400.000	78587.500	77627.397	11892.908	86555.554	89615.522	89615.522
Metals	D	MANGANESE	ug/l	8	8	1.000	.100	187.000	187.000	377.000	293.250	287.461	59.341	333.008	346.705
Metals	D	MERCURY	ug/l	0	8	0.000	.100	.100	.100	.100	.100	.100	.000	.100	.100
Metals	D	MOLYBDENUM	ug/l	1	8	.125	2.000	7.500	9.800	9.800	4.663	3.918	2.913	6.614	8.905
Metals	D	NICKEL	ug/l	1	8	.125	2.500	7.000	9.600	9.600	4.888	4.419	2.444	6.525	7.449
Metals	D	POTASSIUM	ug/l	8	8	1.000	.500	8890.000	11300.000	10090.000	10056.832	10056.832	871.452	10673.859	10723.618
Metals	D	SELENIUM	ug/l	0	8	0.000	.500	1.500	1.500	1.500	.819	.753	.366	1.064	1.196
Metals	D	SILICON	ug/l	8	8	1.000	1.500	6.500	5840.000	6700.000	6355.000	6349.628	276.922	6540.533	6550.275
Metals	D	SILVER	ug/l	1	8	.125	1.500	6.500	6.400	6.400	2.800	2.239	2.260	4.314	5.401
Metals	D	SODIUM	ug/l	8	8	1.000	1.000	425000.000	520000.000	497000.000	495617.989	39122.518	523211.449	525686.791	525686.791
Metals	D	STRONTIUM	ug/l	8	8	1.000	.500	3860.000	5390.000	4892.500	4869.541	483.876	5216.689	5275.495	5275.495
Metals	D	THALLIUM	ug/l	0	8	0.000	.500	2.000	.944	.944	.792	.792	.618	1.358	1.738
Metals	D	TIN	ug/l	3	8	.375	5.000	6.500	36.900	46.100	19.150	12.151	18.463	31.520	77.019

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "\*" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-15  
IHSS 200: Great Western Reservoir  
Groundwater Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	D	VANADIUM	ug/l	0	8	0.000	1.000	7.000			3.231	2.597	2.392	4.834	6.758
Metals	D	ZINC	ug/l	3	8	.375	1.000	1.500	5.600	47.600	8.319	2.992	16.029	19.058	63.305
Metals	T	ALUMINUM	ug/l	8	8	1.000			965.000	23400.000	8499.375	4422.851	9254.575	14699.789	68536.011
Metals	T	ANTIMONY	ug/l	1	8	.125	6.500	18.000	27.500	27.500	12.750	11.272	7.231	17.595	20.481
Metals	T	ARSENIC	ug/l	5	8	.625	.850	1.500	2.300	6.900	2.994	2.370	2.130	4.421	7.021
Metals	T	BARIIUM	ug/l	8	8	1.000		.500	34.800	166.000	80.300	63.851	59.329	120.049	170.416
Metals	T	BERYLLIUM	ug/l	4	8	.500	1.000	2.000	1.100	1.600	.913	.808	.473	1.230	1.504
Metals	T	CADMIUM	ug/l	1	8	.125	1.000	2.000	2.800	2.800	1.663	1.575	.595	2.061	2.222
Metals	T	CALCIUM	ug/l	8	8	1.000			273000.000	352000.000	314250.000	313249.928	26762.180	332180.224	333619.264
Metals	T	CESIUM	ug/l	2	8	.250	6.000	25.000	25.000	50.000	19.938	16.057	14.216	29.462	43.910
Metals	T	CHROMIUM	ug/l	5	8	.625	2.000	2.600	3.700	29.000	11.038	6.484	11.048	18.440	62.270
Metals	T	COBALT	ug/l	4	8	.500	1.500	3.000	5.300	16.600	6.400	4.548	5.665	10.195	19.265
Metals	T	COPPER	ug/l	8	8	1.000			4.800	39.700	16.350	11.817	13.776	25.579	46.889
Metals	T	IRON	ug/l	8	8	1.000		1.000	2210.000	27100.000	11575.000	6999.251	11442.736	19241.446	56260.507
Metals	T	LEAD	ug/l	7	8	.875	1.000	1.000	1.800	20.100	7.888	4.757	7.722	13.061	43.045
Metals	T	LITHIUM	ug/l	8	8	1.000			349.000	465.000	420.500	418.845	38.998	446.628	449.953
Metals	T	MAGNESIUM	ug/l	8	8	1.000			55300.000	97700.000	80487.500	79595.029	12075.292	88577.749	90887.191
Metals	T	MANGANESE	ug/l	8	8	1.000			327.000	959.000	485.250	449.542	227.264	637.513	672.971
Metals	T	MERCURY	ug/l	0	8	0.000	.100	.100			.100	.100	.000	.100	
Metals	T	MOLYBDENUM	ug/l	0	8	0.000	2.500	8.000			5.150	4.764	2.013	6.499	7.644
Metals	T	NICKEL	ug/l	2	8	.250	3.000	16.550	24.000	30.300	11.669	8.015	10.633	18.793	38.268
Metals	T	POTASSIUM	ug/l	8	8	1.000			10200.000	14800.000	11925.000	11819.394	1737.609	13089.170	13199.400
Metals	T	SELENIUM	ug/l	2	8	.250	.500	5.000	1.600	1.600	2.150	1.622	1.798	3.355	5.347
Metals	T	SILICON	ug/l	8	8	1.000			8140.000	53600.000	23485.000	17887.838	18505.896	35883.648	56707.213
Metals	T	SILVER	ug/l	0	8	0.000	1.500	2.500			1.688	1.657	.372	1.937	1.947
Metals	T	SODIUM	ug/l	8	8	1.000			403000.000	533000.000	488000.000	486428.444	40482.801	515122.816	518861.531

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this station only.) The actual meaning of this result is questionable.

Table C-15  
IHSS 200: Great Western Reservoir  
Groundwater Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
											Mean	Mean	Mean	Mean			
Metals	T	STRONTIUM	ug/l	8	8	1.000			3860.000	5590.000	4873.750	4850.221	495.723	5205.876	5258.388		
Metals	T	THALLIUM	ug/l	0	8	0.000	.500	2.000			.938	.783	.623	1.355	1.749		
Metals	T	TIN	ug/l	2	8	.250	5.000	14.500	38.400	47.800	16.275	10.783	17.018	27.677	49.987		
Metals	T	VANADIUM	ug/l	4	8	.500	1.450	7.000	6.200	70.200	25.756	10.862	29.488	45.513	582.863		
Metals	T	ZINC	ug/l	8	8	1.000			18.200	158.000	63.200	42.866	58.033	102.081	208.732		
Radionuclides	D	URANIUM-233/234	pCi/l	6	6	1.000			.260	4.840	2.750	2.056	1.556	4.030	27.493		
Radionuclides	D	URANIUM-235	pCi/l	6	6	1.000			.028	.290	.135	.094	.117	.231	.883		
Radionuclides	D	URANIUM-238	pCi/l	6	6	1.000			.260	2.500	1.653	1.298	.916	2.407	8.954		
Radionuclides	T	AMERICIUM-241	pCi/l	7	7	1.000			0.000	.021	.007	.012	.008	.013	691.924 *		
Radionuclides	T	PLUTONIUM-239/240	pCi/l	7	7	1.000			-.013	.085	.011	.071	.033	.036	2.5120e+008 *		
Radionuclides	T	URANIUM-233/234	pCi/l	2	2	1.000			3.400	4.600	4.000	3.955	.849	7.788			
Radionuclides	T	URANIUM-235	pCi/l	2	2	1.000			.120	.200	.160	.155	.057	.413			
Radionuclides	T	URANIUM-238	pCi/l	2	2	1.000			2.100	4.200	3.150	2.970	1.485	9.780			
Water Quality	T	BICARBONATE AS CaCO3	mg/l	8	8	1.000			230.000	445.820	372.294	365.764	68.675	418.305	436.873		
Water Quality	T	CARBONATE AS CaCO3	mg/l	2	8	.250	.355	.500	1.140	2.900	.862	.662	.857	1.436	1.675		
Water Quality	T	CHLORIDE	mg/l	8	8	1.000			86.000	110.000	97.540	97.271	7.737	102.723	103.112		
Water Quality	T	FLUORIDE	mg/l	8	8	1.000			.260	.400	.305	.303	.042	.333	.334		
Water Quality	T	NITRATE/NITRITE	mg/l	5	8	.625	.010	.019	.300	.522	.285	.115	.236	.443	38.761		
Water Quality	T	SULFATE	mg/l	8	8	1.000			1600.000	3800.000	2023.875	1937.542	744.887	2522.937	2535.175		
Water Quality	T	TOTAL DISSOLVED SOLIDS	mg/l	8	8	1.000			2500.000	3183.000	2995.500	2987.707	222.354	3144.473	3164.759		
Water Quality	T	TOTAL SUSPENDED SOLIDS	mg/l	8	8	1.000			17.000	1300.000	443.875	198.653	503.043	780.905	9054.276		

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "##" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-16  
IHSS 201: Standley Lake  
Groundwater Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	D	ALUMINIUM	ug/l	0	8	0.000	6.500	20.000			13.675	12.605	5.537	17.385	20.387
Metals	D	ANTIMONY	ug/l	0	8	0.000	6.500	18.000			12.056	11.225	4.645	15.168	17.308
Metals	D	ARSENIC	ug/l	6	8	.750	1.000	1.500	2.000	25.000	5.138	2.898	8.070	10.544	15.434
Metals	D	BARIUM	ug/l	7	8	.875	8.000	8.000	29.300	35.000	28.625	26.560	8.504	34.323	45.993
Metals	D	BERYLLIUM	ug/l	0	8	0.000	.500	.500			.500	.500		.500	.500
Metals	D	CADMIUM	ug/l	0	8	0.000	1.000	2.000			1.438	1.384	.417	1.717	1.817
Metals	D	CALCIUM	ug/l	8	8	1.000	6.000	18.000	84900.000	98100.000	88312.500	88222.987	4348.542	91225.952	91243.511
Metals	D	CESIUM	ug/l	2	6	.333	6.000	18.000	19.000	41.000	18.500	15.747	11.958	28.337	43.916
Metals	D	CHROMIUM	ug/l	0	8	0.000	1.000	2.000			1.625	1.588	.354	1.862	1.947
Metals	D	COBALT	ug/l	0	8	0.000	1.500	3.000			2.063	1.997	.563	2.440	2.547
Metals	D	COPPER	ug/l	1	8	.125	1.000	2.000	2.700	2.700	1.463	1.346	.674	1.914	2.096
Metals	D	IRON	ug/l	8	8	1.000	.500	1.000	498.000	715.000	617.625	613.170	78.249	670.050	677.848
Metals	D	LEAD	ug/l	1	8	.125	1.000	1.000	5.800	5.800	1.288	.808	1.837	2.518	3.156
Metals	D	LITHIUM	ug/l	8	8	1.000	1.000	1.000	67.800	81.400	75.675	75.543	4.722	78.839	79.088
Metals	D	MAGNESIUM	ug/l	8	8	1.000	1.000	1.000	21200.000	23800.000	22000.000	21985.768	858.570	22575.228	22581.121
Metals	D	MANGANESE	ug/l	8	8	1.000	.100	.100	53.200	64.900	58.800	58.622	4.920	62.096	62.318
Metals	D	MERCURY	ug/l	0	8	0.000	2.000	7.500			4.163	3.749	.000	.100	.100
Metals	D	MOLYBDENUM	ug/l	1	8	.125	2.500	7.000	5.100	5.100	4.150	3.927	1.998	5.501	6.549
Metals	D	NICKEL	ug/l	0	8	0.000	2.500	7.000			4.150	3.927	1.533	5.177	5.520
Metals	D	POTASSIUM	ug/l	8	8	1.000	.500	1.500	2890.000	4020.000	3575.000	3555.741	386.153	3833.716	3873.527
Metals	D	SELENIUM	ug/l	1	8	.125	1.500	1.500	1.500	1.500	.969	.898	.388	1.229	1.412
Metals	D	SILICON	ug/l	8	8	1.000	1.500	6.500	4760.000	5510.000	5267.500	5262.814	233.162	5423.714	5434.618
Metals	D	SILVER	ug/l	0	8	0.000	1.500	6.500			2.313	1.991	1.731	3.472	3.609
Metals	D	SODIUM	ug/l	8	8	1.000	1.500	6.500	243000.000	276000.000	262500.000	262297.453	10915.258	269813.045	270198.068
Metals	D	STRONTIUM	ug/l	8	8	1.000	.500	2.000	1090.000	1290.000	1163.750	1162.408	60.695	1204.415	1205.216
Metals	D	THALLIUM	ug/l	1	8	.125	5.000	6.500	1.200	1.200	1.025	.873	.602	1.428	1.900
Metals	D	TIN	ug/l	3	8	.375	5.000	6.500	31.200	46.300	17.550	11.615	16.671	28.719	61.386

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this estimation only.) The actual meaning of this result is questionable.

Table C-16  
IHSS 201: Standley Lake  
Groundwater Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic Mean	Geometric Mean	Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
Metals	D	VANADIUM	ug/l	0	8	0.000	1.000	7.000			3.188	2.501	2.434	4.818	7.264
Metals	D	ZINC	ug/l	3	8	.375	1.500	5.350	3.100	16.500	4.800	3.413	4.974	8.132	12.579
Metals	T	ALUMINUM	ug/l	5	8	.625	12.050	23.400	28.200	338.000	72.019	40.618	108.713	144.855	244.368
Metals	T	ANTIMONY	ug/l	0	8	0.000	6.500	18.000			11.000	10.313	4.217	13.826	15.230
Metals	T	ARSENIC	ug/l	5	8	.625	1.000	1.500	2.700	3.800	2.525	2.287	1.071	3.243	4.068
Metals	T	BARIUM	ug/l	8	8	1.000	.500	.500	29.300	38.500	32.913	32.771	3.323	35.139	35.271
Metals	T	BERYLLIUM	ug/l	0	8	0.000	1.000	2.000			.500	.500	.417	.500	.500
Metals	T	CADMIUM	ug/l	0	8	0.000	1.000	2.000			1.438	1.384		1.717	1.817
Metals	T	CALCIUM	ug/l	8	8	1.000	6.000	18.000	82200.000	99100.000	88975.000	88839.571	5312.989	92534.616	92649.266
Metals	T	CESIUM	ug/l	0	5	0.000	1.500	2.000	2.500	2.500	11.000	10.036	5.184	15.943	22.632
Metals	T	CHROMIUM	ug/l	1	8	.125	1.500	3.000			1.813	1.781	.372	2.062	2.099
Metals	T	COBALT	ug/l	0	8	0.000	1.500	3.000			2.063	1.997	.563	2.440	2.547
Metals	T	COPPER	ug/l	2	8	.250	1.000	2.000	4.400	4.900	2.038	1.601	1.654	3.146	4.217
Metals	T	IRON	ug/l	8	8	1.000	.500	.500	753.000	1300.000	898.500	885.965	174.585	1015.469	1018.549
Metals	T	LEAD	ug/l	1	8	.125	1.000	1.000			.775	.693	.437	1.068	1.183
Metals	T	LITHIUM	ug/l	8	8	1.000	2.000	7.500	72.200	78.600	74.850	74.825	2.056	76.227	76.253
Metals	T	MAGNESIUM	ug/l	8	8	1.000	2.500	7.000	20700.000	24300.000	22087.500	22062.644	1133.185	22846.715	22866.513
Metals	T	MANGANESE	ug/l	8	8	1.000	.100	.100	52.800	70.200	60.113	59.879	5.717	63.943	64.209
Metals	T	MERCURY	ug/l	0	8	0.000	1.000	2.000			.100	.100	.000	.100	.100
Metals	T	MOLYBDENUM	ug/l	1	8	.125	2.000	7.500	10.200	10.200	5.200	4.610	2.673	6.991	8.703
Metals	T	NICKEL	ug/l	0	8	0.000	2.500	7.000			4.125	3.896	1.553	5.165	5.520
Metals	T	POTASSIUM	ug/l	7	8	.875	2045.000	2045.000	3210.000	3830.000	3430.625	3372.527	597.151	3830.706	4028.511
Metals	T	SELENIUM	ug/l	0	8	0.000	.500	1.500			.875	.811	.354	1.112	1.268
Metals	T	SILICON	ug/l	8	8	1.000	1.500	2.500	5110.000	6260.000	5535.000	5520.504	432.633	5824.857	5840.072
Metals	T	SILVER	ug/l	0	8	0.000	1.500	2.500			1.688	1.657	.372	1.937	1.947
Metals	T	SODIUM	ug/l	8	8	1.000	258000.000	268000.000	262875.000	262852.908	262875.000	262852.908	3642.507	265315.420	265346.908

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

- (1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.
- (2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.
- (\*) A "" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

Table C-16  
IHSS 201: Standley Lake  
Groundwater Samples

Test Group	T/D	Chemical Name	Units	No. of Detects	No. of Samples	Detect Freq	Minimum Nondetect	Maximum Nondetect	Minimum Detected	Maximum Detected	Arithmetic		Geometric		Standard Deviation	Normal 95% UCL (1)	Lognormal 95% UCL (2) *
											Mean	Mean	Mean	Mean			
Metals	T	STRONTIUM	ug/l	8	8	1,000	1090.000	1280.000	1160.000	1158.130	71.114	1207.645	1209.422				
Metals	T	THALLIUM	ug/l	0	8	0.000	.500	2.000	.938	.783	.623	1.355	1.749				
Metals	T	TIN	ug/l	0	8	0.000	5.000	14.500	9.063	8.188	4.411	12.018	13.910				
Metals	T	VANADIUM	ug/l	0	8	0.000	1.000	7.000	3.188	2.501	2.434	4.818	7.264				
Metals	T	ZINC	ug/l	3	8	.375	1.000	6.300	6.950	4.335	6.686	11.430	36.856				
Radionuclides	D	RADIUM-226	pCi/l	1	1	1,000	.700	.700	.700	.700	.700	.700	.700				
Radionuclides	D	STRONTIUM-89/90	pCi/l	1	1	1,000	.040	.040	.040	.040	.040	.040	.040				
Radionuclides	D	TOTAL RADIOCESIUM	pCi/l	1	1	1,000	.320	.320	.320	.320	.320	.320	.320				
Radionuclides	D	URANIUM-233/234	pCi/l	6	6	1,000	.312	1.200	.694	.631	.322	.959	1.252				
Radionuclides	D	URANIUM-235	pCi/l	6	6	1,000	-.025	.180	.063	.211	.075	.125	1.3181e+019 *				
Radionuclides	D	URANIUM-238	pCi/l	6	6	1,000	.134	.700	.466	.406	.226	.651	1.148				
Radionuclides	T	AMERICIUM-241	pCi/l	7	7	1,000	.001	.010	.005	.004	.003	.007	.013				
Radionuclides	T	PLUTONIUM-239/240	pCi/l	7	7	1,000	-.001	.001	.000	.139	.001	.001	.466 *				
Radionuclides	T	URANIUM-233/234	pCi/l	2	2	1,000	.640	.870	.755	.746	.163	1.481					
Radionuclides	T	URANIUM-235	pCi/l	2	2	1,000	0.000	.083	.042	.288	.059	.304	*				
Radionuclides	T	URANIUM-238	pCi/l	2	2	1,000	.700	.910	.805	.798	.148	1.468					
Water Quality	T	BICARBONATE AS CAC03	mg/l	8	8	1,000	420.000	480.000	444.081	443.745	18.669	456.589	456.847				
Water Quality	T	CARBONATE AS CAC03	mg/l	2	8	.250	.500	5.100	1.298	.815	1.650	2.403	3.657				
Water Quality	T	CHLORIDE	mg/l	8	8	1,000	24.690	33.000	29.259	29.053	3.665	31.714	32.065				
Water Quality	T	FLUORIDE	mg/l	8	8	1,000	.890	1.000	.939	.938	.048	.971	.972				
Water Quality	T	NITRATE/NITRITE	mg/l	4	8	.500	.010	.035	.031	.024	.023	.047	.080				
Water Quality	T	SULFATE	mg/l	8	8	1,000	340.000	690.000	436.013	424.996	115.158	513.166	519.057				
Water Quality	T	TOTAL DISSOLVED SOLIDS	mg/l	8	8	1,000	1000.000	1100.000	1071.500	1070.664	44.603	1101.383	1103.188				
Water Quality	T	TOTAL SUSPENDED SOLIDS	mg/l	2	8	.250	1.850	2.500	3.419	2.820	2.650	5.194	6.085				

NOTES: Source table for summary statistics was DA091994.db.

Concentration values should be considered significant to only two places.

T/D = Total (unfiltered) / Dissolved (filtered).

(1) Normal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Normal. Uses t-Statistics.

(2) Lognormal 95% UCL is the 95% Upper Confidence Limit under the assumption that the distribution is Lognormal. Uses h-Statistics.

(\*) A "0" in this column indicates that the Lognormal 95% UCL was computed on a data set containing non-positive values. Since the natural log of each value is required for the calculation, a value of 0.00001 was substituted (for this calculation only.) The actual meaning of this result is questionable.

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## APPENDIX D. CONCENTRATION-TOXICITY SCREEN SUMMARY

Appendix D contains tables summarizing the results of the concentration-toxicity screen performed on the OU 3 data (DA061094.DB). The objective of this screening procedure is to identify the chemicals in a particular medium and IHSS that, based on concentration and toxicity, are most likely to contribute significantly to risks calculated for exposure scenarios involving that medium and IHSS; thus, the risk assessment is focused on the "most significant" chemicals. The contamination-toxicity screen was performed following guidance developed by EPA in Risk Assessment Guidance for Superfund. Volume 1: Part A, Human Health Evaluation Manual (EPA, 1989).

The contamination-toxicity screen was accomplished using a computer program (Paradox script) that performed the following steps:

1. Chemicals that are considered essential nutrients and those chemicals that were detected in less than 5 percent of the samples were removed from consideration as COCs.
2. The general parameters Gross Alpha and Gross Beta were removed from the data set.
3. The data were grouped by medium (SAMPLE TYPE) and IHSS. For each chemical in each group, the maximum detected concentration was determined.
4. The chemical risk factor was calculated either by multiplying the maximum chemical concentration by the corresponding slope factor (SF) for carcinogens or by dividing the maximum chemical concentration by the corresponding reference dose (RfD) for chemicals with noncarcinogenic effects. For chemicals with both oral and inhalation toxicity values, the more conservative toxicity factors (i.e., greater SF for carcinogens and lower RfD for chemicals with noncarcinogenic effects) were used to calculate the chemical risk factors.

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When possible, SF and RfD values were taken from the Programmatic Preliminary Remediation Goals (DOE, 1994) included as Attachment 1, Appendix E.

5. For each group, the total risk factor was calculated (i.e., the sum of all the chemical specific risk factors). Using these totals, each chemical was assigned two percentage values (one for carcinogenic effects and one for non-carcinogenic effect) representing contributions to the total risk factor.

The reports in this appendix show the results of the above process. The chemicals are ranked according to the percentage of their contribution to the total risk factor. The cumulative percentages are listed and those chemicals contributing to the upper 99-percent of the risk or hazard index are identified.

Tables D-1 through D-9 summarize the results of the contamination-toxicity screen of OU 3 data for surface soil, sediment, surface water, and groundwater. The screen performed for each analyte by IHSS and media type in Tables D-1 through D-9 include:

- Table D-1a – Total Radionuclides – Surface Soils (Carinogenic Risk)
- Table D-2a – Total Radionuclides – Surface Sediments (Carinogenic Risk)
- Table D-3a – Total Non-radionuclides – Surface Sediments (Carinogenic Risk)
- Table D-3b – Total Non-radionuclides – Surface Sediments (Noncarinogenic Effect)
- Table D-4a – Total Radionuclides – IHSS 200 Subsurface Sediments (Carinogenic Risk)
- Table D-5a – Total Non-radionuclides – IHSS 200 Subsurface Sediments (Carinogenic Risk)

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- Table D-5b – Total Non-radionuclides – IHSS 200 Subsurface Sediments (Noncarcinogenic Effect)
- Table D-6a – Total Radionuclides – Surface Water (Carcinogenic Risk)
- Table D-7a – Total Non-radionuclides – Surface Water (Carcinogenic Risk)
- Table D-7b – Total Non-radionuclides – Surface Water (Noncarcinogenic Effect)
- Table D-8a – Total Radionuclides – Groundwater (Carcinogenic Risk)
- Table D-9a – Total Non-radionuclides – Groundwater (Carcinogenic Risk)
- Table D-9b – Total Non-radionuclides – Groundwater (Noncarcinogenic Effect)

The risk factors developed in this screening procedure are used only for potential reduction of the number of chemicals carried through the risk assessment and have no meaning outside of the context of the screening procedure.

#### REFERENCES

DOE, 1994. United States Department of Energy. Draft Final Rocky Flats Programmatic Preliminary Remediation Goals. June 1994.

EPA, 1989. United States Environmental Protection Agency. Risk Assessment Guidance for Superfund. Volume 1: Part A, Human Health Evaluation Manual. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-89/002. December 1989.

Table D-2a  
Total Radionuclides - Surface Sediments (Grab Samples)  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
URANIUM-233/234	YES	35.092	35.092	NO
PLUTONIUM-239/240	YES	31.343	66.435	NO
URANIUM-238	YES	26.394	92.829	NO
URANIUM-235	YES	3.499	96.328	YES
RADIUM-226	YES	1.650	97.977	NO
AMERICIUM-241	YES	1.648	99.625	NO
RADIUM-228	NO	.363	99.988	NO
STRONTIUM-89/90	NO	.008	99.996	NO
CESIUM-137	NO	.004	100.000	NO
TRITIUM	NO	.000	100.000	NO

IHSS 201: Standley Lake

URANIUM-233/234	YES	48.775	48.775	NO
URANIUM-238	YES	37.360	86.135	NO
PLUTONIUM-239/240	YES	8.388	94.523	NO
URANIUM-235	YES	1.996	96.519	YES
RADIUM-226	YES	1.676	98.195	NO
AMERICIUM-241	YES	1.367	99.562	NO
RADIUM-228	NO	.421	99.983	NO
STRONTIUM-89/90	NO	.016	99.999	NO
CESIUM-137	NO	.001	100.000	NO
TRITIUM	NO	.000	100.000	NO

IHSS 202: Mower Reservoir

URANIUM-233/234	YES	46.437	46.437	NO
URANIUM-238	YES	40.416	86.853	NO
PLUTONIUM-239/240	YES	9.461	96.315	NO
URANIUM-235	YES	2.169	98.483	NO
AMERICIUM-241	YES	1.517	100.000	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or Rfd) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-3a  
Total Non-radionuclides - Surface Sediments (Grab Samples)  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
CHROMIUM	YES	83.055	83.055	NO
ARSENIC	YES	14.474	97.529	YES
BERYLLIUM	YES	1.375	98.904	YES
CADMIUM	YES	1.096	100.000	NO
ALUMINUM	NO	0.000	100.000	
ANTIMONY	NO	0.000	100.000	NO
BARIUM	NO	0.000	100.000	NO
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
COPPER	NO	0.000	100.000	NO
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
MANGANESE	NO	0.000	100.000	YES
MERCURY	NO	0.000	100.000	NO
MOLYBDENUM	NO	0.000	100.000	NO
NICKEL	NO	0.000	100.000	NO
SELENIUM	NO	0.000	100.000	NO
SILICON	NO	0.000	100.000	
SILVER	NO	0.000	100.000	NO
STRONTIUM	NO	0.000	100.000	NO
TIN	NO	0.000	100.000	NO
VANADIUM	NO	0.000	100.000	NO
ZINC	NO	0.000	100.000	NO
CALCIUM		0.000		
CYANIDE		0.000		
IRON		0.000		
MAGNESIUM		0.000		
POTASSIUM		0.000		
SODIUM		0.000		
THALLIUM		0.000		

IHSS 201: Standley Lake

CHROMIUM	YES	80.367	80.367	NO
ARSENIC	YES	16.369	96.735	YES
CADMIUM	YES	2.439	99.174	NO
BERYLLIUM	NO	.826	100.000	YES
ALUMINUM	NO	0.000	100.000	
ANTIMONY	NO	0.000	100.000	NO
BARIUM	NO	0.000	100.000	NO
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
COPPER	NO	0.000	100.000	NO
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	

NOTES: (1) A value of zero signifies that no toxicity value (SF or Rfd) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-3a  
Total Non-radionuclides - Surface Sediments (Grab Samples)  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 201: Standley Lake				
MANGANESE	NO	0.000	100.000	YES
MERCURY	NO	0.000	100.000	NO
MOLYBDENUM	NO	0.000	100.000	NO
NICKEL	NO	0.000	100.000	NO
SELENIUM	NO	0.000	100.000	NO
SILICON	NO	0.000	100.000	
SILVER	NO	0.000	100.000	NO
STRONTIUM	NO	0.000	100.000	NO
TIN	NO	0.000	100.000	NO
VANADIUM	NO	0.000	100.000	NO
ZINC	NO	0.000	100.000	NO
CALCIUM		0.000		
IRON		0.000		
MAGNESIUM		0.000		
POTASSIUM		0.000		
SODIUM		0.000		
THALLIUM		0.000		
IHSS 202: Mower Reservoir				
CHROMIUM	YES	84.271	84.271	NO
ARSENIC	YES	14.557	98.828	YES
BERYLLIUM	YES	1.172	100.000	YES
METHYLENE CHLORIDE	NO	.000	100.000	NO
2-BUTANONE	NO	0.000	100.000	NO
ACETONE	NO	0.000	100.000	NO
ALUMINUM	NO	0.000	100.000	
ANTIMONY	NO	0.000	100.000	NO
BARIUM	NO	0.000	100.000	NO
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
COPPER	NO	0.000	100.000	NO
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
MANGANESE	NO	0.000	100.000	NO
MERCURY	NO	0.000	100.000	NO
NICKEL	NO	0.000	100.000	NO
SELENIUM	NO	0.000	100.000	NO
SILICON	NO	0.000	100.000	
SILVER	NO	0.000	100.000	NO
STRONTIUM	NO	0.000	100.000	NO
THALLIUM	NO	0.000	100.000	
TIN	NO	0.000	100.000	NO
TOLUENE	NO	0.000	100.000	NO
TOTAL XYLENES	NO	0.000	100.000	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 202: Mower Reservoir				
TRICHLOROTRIFLUOROETHANE	NO	0.000	100.000	NO
UNKNOWN	NO	0.000	100.000	
UNKNOWN-1	NO	0.000	100.000	
UNKNOWN-2	NO	0.000	100.000	
VANADIUM	NO	0.000	100.000	NO
ZINC	NO	0.000	100.000	NO
1,1,1-TRICHLOROETHANE		0.000		
1,1,2,2-TETRACHLOROETHANE		0.000		
1,1,2-TRICHLOROETHANE		0.000		
1,1-DICHLOROETHANE		0.000		
1,1-DICHLOROETHENE		0.000		
1,2-DICHLOROETHANE		0.000		
1,2-DICHLOROETHENE		0.000		
1,2-DICHLOROPROPANE		0.000		
2-HEXANONE		0.000		
4-METHYL-2-PENTANONE		0.000		
BENZENE		0.000		
BROMODICHLOROMETHANE		0.000		
BROMOFORM		0.000		
BROMOMETHANE		0.000		
CADMIUM		0.000		
CALCIUM		0.000		
CARBON DISULFIDE		0.000		
CARBON TETRACHLORIDE		0.000		
CHLOROBENZENE		0.000		
CHLOROETHANE		0.000		
CHLOROFORM		0.000		
CHLOROMETHANE		0.000		
CIS-1,3-DICHLOROPROPENE		0.000		
CYANIDE		0.000		
DIBROMOCHLOROMETHANE		0.000		
ETHYLBENZENE		0.000		
IRON		0.000		
MAGNESIUM		0.000		
MOLYBDENUM		0.000		
POTASSIUM		0.000		
SODIUM		0.000		
STYRENE		0.000		
TETRACHLOROETHENE		0.000		
TRANS-1,3-DICHLOROPROPENE		0.000		
TRICHLOROETHENE		0.000		
VINYL ACETATE		0.000		
VINYL CHLORIDE		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-3b  
Total Non-radionuclides - Surface Sediments (Grab Samples)  
(Noncarcinogenic Effects)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
MANGANESE	YES	98.364	98.364	YES
BARIUM	YES	1.544	99.908	NO
ANTIMONY	NO	.030	99.938	NO
ARSENIC	NO	.028	99.966	YES
VANADIUM	NO	.011	99.978	NO
CHROMIUM	NO	.004	99.981	NO
NICKEL	NO	.003	99.985	NO
MOLYBDENUM	NO	.003	99.988	NO
CADMIUM	NO	.003	99.991	NO
COPPER	NO	.003	99.994	NO
MERCURY	NO	.002	99.996	NO
ZINC	NO	.002	99.998	NO
SILVER	NO	.001	99.999	NO
SELENIUM	NO	.001	99.999	NO
BERYLLIUM	NO	.000	100.000	YES
STRONTIUM	NO	.000	100.000	NO
TIN	NO	.000	100.000	NO
ALUMINUM	NO	0.000	100.000	
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
SILICON	NO	0.000	100.000	
CALCIUM		0.000		
CYANIDE		0.000		
IRON		0.000		
MAGNESIUM		0.000		
POTASSIUM		0.000		
SODIUM		0.000		
THALLIUM		0.000		

IHSS 201: Standley Lake

MANGANESE	YES	99.226	99.226	YES
BARIUM	NO	.734	99.960	NO
ARSENIC	NO	.019	99.979	YES
ANTIMONY	NO	.006	99.984	NO
CADMIUM	NO	.004	99.988	NO
VANADIUM	NO	.003	99.991	NO
MERCURY	NO	.002	99.993	NO
CHROMIUM	NO	.002	99.995	NO
COPPER	NO	.001	99.997	NO
ZINC	NO	.001	99.998	NO
MOLYBDENUM	NO	.000	99.999	NO
SILVER	NO	.000	99.999	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-3b  
Total Non-radionuclides - Surface Sediments (Grab Samples)  
(Noncarcinogenic Effects)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 201: Standley Lake				
NICKEL	NO	.000	99.999	NO
SELENIUM	NO	.000	100.000	NO
STRONTIUM	NO	.000	100.000	NO
BERYLLIUM	NO	.000	100.000	YES
TIN	NO	.000	100.000	NO
ALUMINUM	NO	0.000	100.000	
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
SILICON	NO	0.000	100.000	
CALCIUM		0.000		
IRON		0.000		
MAGNESIUM		0.000		
POTASSIUM		0.000		
SODIUM		0.000		
THALLIUM		0.000		

IHSS 202: Mower Reservoir

MANGANESE	YES	97.407	97.407	NO
BARIUM	YES	2.467	99.874	NO
ANTIMONY	NO	.051	99.926	NO
ARSENIC	NO	.041	99.967	YES
VANADIUM	NO	.019	99.986	NO
CHROMIUM	NO	.005	99.992	NO
NICKEL	NO	.002	99.993	NO
COPPER	NO	.001	99.995	NO
MERCURY	NO	.001	99.996	NO
SELENIUM	NO	.001	99.998	NO
ZINC	NO	.001	99.998	NO
STRONTIUM	NO	.001	99.999	NO
SILVER	NO	.000	100.000	NO
BERYLLIUM	NO	.000	100.000	YES
TIN	NO	.000	100.000	NO
ACETONE	NO	.000	100.000	NO
TOLUENE	NO	.000	100.000	NO
METHYLENE CHLORIDE	NO	.000	100.000	NO
2-BUTANONE	NO	.000	100.000	NO
TRICHLOROTRIFLUOROETHANE	NO	.000	100.000	NO
TOTAL XYLENES	NO	.000	100.000	NO
ALUMINUM	NO	0.000	100.000	
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
LEAD	NO	0.000	100.000	

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
-----				
IHSS 202: Mower Reservoir				
LITHIUM	NO	0.000	100.000	
SILICON	NO	0.000	100.000	
THALLIUM	NO	0.000	100.000	
UNKNOWN	NO	0.000	100.000	
UNKNOWN-1	NO	0.000	100.000	
UNKNOWN-2	NO	0.000	100.000	
1,1,1-TRICHLOROETHANE		0.000		
1,1,2,2-TETRACHLOROETHANE		0.000		
1,1,2-TRICHLOROETHANE		0.000		
1,1-DICHLOROETHANE		0.000		
1,1-DICHLOROETHENE		0.000		
1,2-DICHLOROETHANE		0.000		
1,2-DICHLOROETHENE		0.000		
1,2-DICHLOROPROPANE		0.000		
2-HEXANONE		0.000		
4-METHYL-2-PENTANONE		0.000		
BENZENE		0.000		
BROMODICHLOROMETHANE		0.000		
BROMOFORM		0.000		
BROMOMETHANE		0.000		
CADMIUM		0.000		
CALCIUM		0.000		
CARBON DISULFIDE		0.000		
CARBON TETRACHLORIDE		0.000		
CHLOROBENZENE		0.000		
CHLOROETHANE		0.000		
CHLOROFORM		0.000		
CHLOROMETHANE		0.000		
CIS-1,3-DICHLOROPROPENE		0.000		
CYANIDE		0.000		
DIBROMOCHLOROMETHANE		0.000		
ETHYLBENZENE		0.000		
IRON		0.000		
MAGNESIUM		0.000		
MOLYBDENUM		0.000		
POTASSIUM		0.000		
SODIUM		0.000		
STYRENE		0.000		
TETRACHLOROETHENE		0.000		
TRANS-1,3-DICHLOROPROPENE		0.000		
TRICHLOROETHENE		0.000		
VINYL ACETATE		0.000		
VINYL CHLORIDE		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
 (2) See Appendix E for calculation methodology and specific PRG values.

Table D-4a  
Total Radionuclides - Subsurface Sediments (Core Samples)  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
PLUTONIUM-239/240	YES	40.335	40.335	NO
URANIUM-233/234	YES	26.708	67.043	NO
URANIUM-238	YES	20.860	87.904	NO
AMERICIUM-241	YES	8.563	96.467	NO
POLONIUM-210	YES	2.150	98.617	NO
URANIUM-235	YES	1.383	100.000	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-5a  
Total Non-radionuclides - Subsurface Sediments (Core Samples)  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
-----				
IHSS 200: Great Western Reservoir				
CHROMIUM	YES	85.701	85.701	NO
ARSENIC	YES	11.643	97.344	NO
BERYLLIUM	YES	1.437	98.782	NO
CADMIUM	YES	1.218	100.000	NO
ALUMINUM	NO	0.000	100.000	
BARIUM	NO	0.000	100.000	
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
COPPER	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
MANGANESE	NO	0.000	100.000	
MERCURY	NO	0.000	100.000	
MOLYBDENUM	NO	0.000	100.000	
NICKEL	NO	0.000	100.000	
SELENIUM	NO	0.000	100.000	
SILVER	NO	0.000	100.000	
STRONTIUM	NO	0.000	100.000	
TIN	NO	0.000	100.000	
VANADIUM	NO	0.000	100.000	
ZINC	NO	0.000	100.000	
CALCIUM		0.000		
IRON		0.000		
MAGNESIUM		0.000		
POTASSIUM		0.000		
SODIUM		0.000		
THALLIUM		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-5b  
Total Non-radionuclides - Subsurface Sediments (Core Samples)  
(Noncarcinogenic Effects)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
MANGANESE	YES	97.281	97.281	NO
BARIUM	YES	2.586	99.867	NO
ARSENIC	NO	.062	99.930	NO
VANADIUM	NO	.016	99.945	NO
COPPER	NO	.014	99.959	NO
CHROMIUM	NO	.010	99.970	NO
CADMIUM	NO	.009	99.979	NO
MERCURY	NO	.006	99.985	NO
SILVER	NO	.006	99.991	NO
ZINC	NO	.003	99.994	NO
NICKEL	NO	.002	99.996	NO
MOLYBDENUM	NO	.002	99.998	NO
SELENIUM	NO	.001	99.999	NO
BERYLLIUM	NO	.001	100.000	NO
STRONTIUM	NO	.000	100.000	NO
TIN	NO	.000	100.000	NO
ALUMINUM	NO	0.000	100.000	
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
CALCIUM		0.000		
IRON		0.000		
MAGNESIUM		0.000		
POTASSIUM		0.000		
SODIUM		0.000		
THALLIUM		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

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Table D-6a  
Total Radionuclides - Surface Water  
(Carcinogenic Risk)

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Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
URANIUM-233/234	YES	36.403	36.403	NO
URANIUM-238	YES	26.392	62.795	NO
TRITIUM	YES	14.774	77.569	NO
URANIUM-235	YES	12.438	90.007	NO
PLUTONIUM-239/240	YES	2.180	100.000	NO
IHSS 201: Standley Lake				
URANIUM-233/234	YES	40.762	40.762	NO
URANIUM-238	YES	34.491	75.253	NO
AMERICIUM-241	YES	12.229	87.482	NO
URANIUM-235	YES	8.466	95.948	NO
PLUTONIUM-239/240	YES	4.052	100.000	NO
IHSS 202: Mower Reservoir				
URANIUM-233/234	YES	35.633	35.633	NO
URANIUM-238	YES	28.246	63.878	NO
PLUTONIUM-239/240	YES	18.740	82.618	NO
AMERICIUM-241	YES	11.081	93.699	NO
URANIUM-235	YES	6.301	100.000	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-7a  
Total Non-radionuclides - Surface Water  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
ARSENIC	YES	74.687	74.687	NO
BERYLLIUM	YES	25.313	100.000	NO
ALUMINUM	NO	0.000	100.000	
BARIUM	NO	0.000	100.000	NO
CADMIUM	NO	0.000	100.000	NO
CESIUM	NO	0.000	100.000	
CHROMIUM	NO	0.000	100.000	NO
COBALT	NO	0.000	100.000	
COPPER	NO	0.000	100.000	NO
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
MANGANESE	NO	0.000	100.000	NO
MOLYBDENUM	NO	0.000	100.000	NO
NICKEL	NO	0.000	100.000	NO
SILICON	NO	0.000	100.000	
STRONTIUM	NO	0.000	100.000	NO
TIN	NO	0.000	100.000	NO
VANADIUM	NO	0.000	100.000	NO
ZINC	NO	0.000	100.000	NO
AMETRYN		0.000		
ANTIMONY		0.000		
ATRATON		0.000		
ATRAZINE		0.000		
CALCIUM		0.000		
CYANIDE		0.000		
IRON		0.000		
MAGNESIUM		0.000		
MERCURY		0.000		
POTASSIUM		0.000		
PROMETON		0.000		
PROMETRYN		0.000		
PROPazine		0.000		
SELENIUM		0.000		
SILVER		0.000		
SIMAZINE		0.000		
SIMETRYN		0.000		
SODIUM		0.000		
TERBUTHYLazine		0.000		
TERBUTRYN		0.000		
THALLIUM		0.000		

IHSS 201: Standley Lake

BERYLLIUM	YES	100.000	100.000	NO
ALUMINUM	NO	0.000	100.000	

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-7a  
Total Non-radionuclides - Surface Water  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 201: Standley Lake				
BARIUM	NO	0.000	100.000	NO
CADMIUM	NO	0.000	100.000	NO
CHROMIUM	NO	0.000	100.000	NO
COBALT	NO	0.000	100.000	
COPPER	NO	0.000	100.000	NO
CYANIDE	NO	0.000	100.000	NO
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
MANGANESE	NO	0.000	100.000	NO
MERCURY	NO	0.000	100.000	NO
MOLYBDENUM	NO	0.000	100.000	NO
NICKEL	NO	0.000	100.000	NO
SELENIUM	NO	0.000	100.000	NO
SILICON	NO	0.000	100.000	
STRONTIUM	NO	0.000	100.000	NO
VANADIUM	NO	0.000	100.000	NO
ZINC	NO	0.000	100.000	NO
ANTIMONY		0.000		
ARSENIC		0.000		
ATRAZINE		0.000		
CALCIUM		0.000		
CESIUM		0.000		
IRON		0.000		
MAGNESIUM		0.000		
POTASSIUM		0.000		
SILVER		0.000		
SIMAZINE		0.000		
SODIUM		0.000		
THALLIUM		0.000		
TIN		0.000		

IHSS 202: Mower Reservoir

ARSENIC	YES	100.000	100.000	NO
ALUMINUM	NO	0.000	100.000	
BARIUM	NO	0.000	100.000	NO
CADMIUM	NO	0.000	100.000	NO
CESIUM	NO	0.000	100.000	
CHROMIUM	NO	0.000	100.000	NO
COPPER	NO	0.000	100.000	NO
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
MANGANESE	NO	0.000	100.000	NO
MERCURY	NO	0.000	100.000	NO
MOLYBDENUM	NO	0.000	100.000	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or Rfd) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-7a  
Total Non-radionuclides - Surface Water  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 202: Mower Reservoir				
NICKEL	NO	0.000	100.000	NO
SILICON	NO	0.000	100.000	NO
STRONTIUM	NO	0.000	100.000	NO
TIN	NO	0.000	100.000	NO
VANADIUM	NO	0.000	100.000	NO
ZINC	NO	0.000	100.000	NO
1,1,1-TRICHLOROETHANE		0.000		
1,1,2,2-TETRACHLOROETHANE		0.000		
1,1,2-TRICHLOROETHANE		0.000		
1,1-DICHLOROETHANE		0.000		
1,1-DICHLOROETHENE		0.000		
1,2-DICHLOROETHANE		0.000		
1,2-DICHLOROETHENE		0.000		
1,2-DICHLOROPROPANE		0.000		
2-BUTANONE		0.000		
2-HEXANONE		0.000		
4-METHYL-2-PENTANONE		0.000		
ACETONE		0.000		
ANTIMONY		0.000		
ATRAZINE		0.000		
BENZENE		0.000		
BERYLLIUM		0.000		
BROMODICHLOROMETHANE		0.000		
BROMOFORM		0.000		
BROMOMETHANE		0.000		
CALCIUM		0.000		
CARBON DISULFIDE		0.000		
CARBON TETRACHLORIDE		0.000		
CHLOROBENZENE		0.000		
CHLOROETHANE		0.000		
CHLOROFORM		0.000		
CHLOROMETHANE		0.000		
CIS-1,3-DICHLOROPROPENE		0.000		
COBALT		0.000		
CYANIDE		0.000		
DIBROMOCHLOROMETHANE		0.000		
ETHYLBENZENE		0.000		
IRON		0.000		
MAGNESIUM		0.000		
METHYLENE CHLORIDE		0.000		
POTASSIUM		0.000		
SELENIUM		0.000		
SILVER		0.000		
SIMAZINE		0.000		
SODIUM		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

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Table D-7a  
Total Non-radionuclides - Surface Water  
(Carcinogenic Risk)

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Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
-----				
IHSS 202: Mower Reservoir				
STYRENE		0.000		
TETRACHLOROETHENE		0.000		
THALLIUM		0.000		
TOLUENE		0.000		
TOTAL XYLENES		0.000		
TRANS-1,3-DICHLOROPROPENE		0.000		
TRICHLOROETHENE		0.000		
VINYL ACETATE		0.000		
VINYL CHLORIDE		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-7b  
Total Non-radionuclides - Surface Water  
(Noncarcinogenic Effects)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
MANGANESE	YES	65.570	65.570	NO
ARSENIC	YES	15.091	80.661	NO
CADMIUM	YES	8.743	89.404	NO
MOLYBDENUM	YES	2.560	91.964	NO
BARIUM	YES	1.786	93.750	NO
VANADIUM	YES	1.784	95.535	NO
CHROMIUM	YES	1.374	96.908	NO
ZINC	YES	.822	97.731	NO
COPPER	YES	.816	98.546	NO
STRONTIUM	YES	.796	99.342	NO
NICKEL	NO	.507	99.850	NO
BERYLLIUM	NO	.125	99.975	NO
TIN	NO	.025	100.000	NO
ALUMINUM	NO	0.000	100.000	
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
SILICON	NO	0.000	100.000	
AMETRYN		0.000		
ANTIMONY		0.000		
ATRATON		0.000		
ATRAZINE		0.000		
CALCIUM		0.000		
CYANIDE		0.000		
IRON		0.000		
MAGNESIUM		0.000		
MERCURY		0.000		
POTASSIUM		0.000		
PROMETON		0.000		
PROMETRYN		0.000		
PROPazine		0.000		
SELENIUM		0.000		
SILVER		0.000		
SIMAZINE		0.000		
SIMETRYN		0.000		
SODIUM		0.000		
TERBUTHYLAZINE		0.000		
TERBUTRYN		0.000		
THALLIUM		0.000		

IHSS 201: Standley Lake

MANGANESE	YES	95.172	95.172	NO
CADMIUM	YES	1.446	96.618	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-7b  
Total Non-radionuclides - Surface Water  
(Noncarcinogenic Effects)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 201: Standley Lake				
MERCURY	YES	.823	97.441	NO
NICKEL	YES	.498	97.940	NO
MOLYBDENUM	YES	.464	98.403	NO
CYANIDE	YES	.324	98.727	NO
SELENIUM	YES	.319	99.046	NO
BARIUM	NO	.191	99.238	NO
ZINC	NO	.185	99.423	NO
CHROMIUM	NO	.175	99.597	NO
VANADIUM	NO	.163	99.761	NO
COPPER	NO	.124	99.885	NO
STRONTIUM	NO	.093	99.978	NO
BERYLLIUM	NO	.022	100.000	NO
ALUMINUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
SILICON	NO	0.000	100.000	
ANTIMONY		0.000		
ARSENIC		0.000		
ATRAZINE		0.000		
CALCIUM		0.000		
CESIUM		0.000		
IRON		0.000		
MAGNESIUM		0.000		
POTASSIUM		0.000		
SILVER		0.000		
SIMAZINE		0.000		
SODIUM		0.000		
THALLIUM		0.000		
TIN		0.000		

IHSS 202: Mower Reservoir

ARSENIC	YES	33.637	33.637	NO
CADMIUM	YES	27.522	61.159	NO
CHROMIUM	YES	20.121	81.280	NO
MANGANESE	YES	11.314	92.595	NO
NICKEL	YES	1.758	94.353	NO
MERCURY	YES	1.529	95.882	NO
VANADIUM	YES	1.398	97.280	NO
MOLYBDENUM	YES	1.345	98.625	NO
BARIUM	YES	.758	99.383	NO
STRONTIUM	NO	.336	99.720	NO
COPPER	NO	.172	99.892	NO
ZINC	NO	.092	99.983	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-7b  
Total Non-radionuclides - Surface Water  
(Noncarcinogenic Effects)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 202: Mower Reservoir				
TIN	NO	.017	100.000	NO
ALUMINUM	NO	0.000	100.000	
CESIUM	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
SILICON	NO	0.000	100.000	
1,1,1-TRICHLOROETHANE		0.000		
1,1,2,2-TETRACHLOROETHANE		0.000		
1,1,2-TRICHLOROETHANE		0.000		
1,1-DICHLOROETHANE		0.000		
1,1-DICHLOROETHENE		0.000		
1,2-DICHLOROETHANE		0.000		
1,2-DICHLOROETHENE		0.000		
1,2-DICHLOROPROPANE		0.000		
2-BUTANONE		0.000		
2-HEXANONE		0.000		
4-METHYL-2-PENTANONE		0.000		
ACETONE		0.000		
ANTIMONY		0.000		
ATRAZINE		0.000		
BENZENE		0.000		
BERYLLIUM		0.000		
BROMODICHLOROMETHANE		0.000		
BROMOFORM		0.000		
BROMOMETHANE		0.000		
CALCIUM		0.000		
CARBON DISULFIDE		0.000		
CARBON TETRACHLORIDE		0.000		
CHLOROBENZENE		0.000		
CHLOROETHANE		0.000		
CHLOROFORM		0.000		
CHLOROMETHANE		0.000		
CIS-1,3-DICHLOROPROPENE		0.000		
COBALT		0.000		
CYANIDE		0.000		
DIBROMOCHLOROMETHANE		0.000		
ETHYLBENZENE		0.000		
IRON		0.000		
MAGNESIUM		0.000		
METHYLENE CHLORIDE		0.000		
POTASSIUM		0.000		
SELENIUM		0.000		
SILVER		0.000		
SIMAZINE		0.000		
SODIUM		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

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Table D-7b  
Total Non-radionuclides - Surface Water  
(Noncarcinogenic Effects)

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Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
-----				
IHSS 202: Mower Reservoir				
STYRENE		0.000		
TETRACHLOROETHENE		0.000		
THALLIUM		0.000		
TOLUENE		0.000		
TOTAL XYLENES		0.000		
TRANS-1,3-DICHLOROPROPENE		0.000		
TRICHLOROETHENE		0.000		
VINYL ACETATE		0.000		
VINYL CHLORIDE		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

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Table D-8a  
Total Radionuclides - Groundwater  
(Carcinogenic Risk)

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Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
URANIUM-233/234	YES	43.656	43.656	YES
URANIUM-238	YES	39.860	83.516	YES
PLUTONIUM-239/240	YES	11.596	95.112	NO
AMERICIUM-241	YES	7.813	97.820	NO
AMERICIUM-241	YES	2.990	98.102	NO
URANIUM-235	YES	1.898	100.000	NO
IHSS 201: Standley Lake				
URANIUM-238	YES	44.886	44.886	NO
URANIUM-233/234	YES	42.913	87.798	NO
AMERICIUM-241	YES	7.399	95.197	NO
URANIUM-235	YES	4.094	99.291	NO
PLUTONIUM-239/240	NO	.709	100.000	NO

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-9a  
Total Non-radionuclides - Groundwater  
(Carcinogenic Risk)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
ARSENIC	YES	63.704	63.704	YES
BERYLLIUM	YES	36.296	100.000	YES
ALUMINUM	NO	0.000	100.000	
ANTIMONY	NO	0.000	100.000	YES
BARIUM	NO	0.000	100.000	NO
CADMIUM	NO	0.000	100.000	NO
CESIUM	NO	0.000	100.000	
CHROMIUM	NO	0.000	100.000	NO
COBALT	NO	0.000	100.000	
COPPER	NO	0.000	100.000	NO
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
MANGANESE	NO	0.000	100.000	YES
NICKEL	NO	0.000	100.000	NO
SELENIUM	NO	0.000	100.000	NO
SILICON	NO	0.000	100.000	
STRONTIUM	NO	0.000	100.000	NO
TIN	NO	0.000	100.000	NO
VANADIUM	NO	0.000	100.000	NO
ZINC	NO	0.000	100.000	NO
CALCIUM		0.000		
IRON		0.000		
MAGNESIUM		0.000		
MERCURY		0.000		
MOLYBDENUM		0.000		
POTASSIUM		0.000		
SILVER		0.000		
SODIUM		0.000		
THALLIUM		0.000		

IHSS 201: Standley Lake

ARSENIC	YES	100.000	100.000	YES
ALUMINUM	NO	0.000	100.000	
BARIUM	NO	0.000	100.000	NO
CHROMIUM	NO	0.000	100.000	NO
COPPER	NO	0.000	100.000	NO
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
MANGANESE	NO	0.000	100.000	NO
MOLYBDENUM	NO	0.000	100.000	NO
SILICON	NO	0.000	100.000	
STRONTIUM	NO	0.000	100.000	NO
ZINC	NO	0.000	100.000	NO
ANTIMONY		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

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Table D-9a  
Total Non-radionuclides - Groundwater  
(Carcinogenic Risk)

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Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 201: Standley Lake				
BERYLLIUM		0.000		
CADMIUM		0.000		
CALCIUM		0.000		
CESIUM		0.000		
COBALT		0.000		
IRON		0.000		
MAGNESIUM		0.000		
MERCURY		0.000		
NICKEL		0.000		
POTASSIUM		0.000		
SELENIUM		0.000		
SILVER		0.000		
SODIUM		0.000		
THALLIUM		0.000		
TIN		0.000		
VANADIUM		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

Table D-9b  
Total Non-radionuclides - Groundwater  
(Noncarcinogenic Effects)

Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 200: Great Western Reservoir				
MANGANESE	YES	59.859	59.859	YES
ANTIMONY	YES	21.456	81.315	YES
ARSENIC	YES	7.178	88.493	YES
VANADIUM	YES	3.130	91.623	NO
STRONTIUM	YES	2.908	94.531	NO
CHROMIUM	YES	1.810	96.341	NO
CADMIUM	YES	1.748	98.088	NO
BARIUM	YES	.740	98.828	NO
NICKEL	YES	.473	99.301	NO
COPPER	NO	.310	99.611	NO
ZINC	NO	.164	99.775	NO
BERYLLIUM	NO	.100	99.875	YES
SELENIUM	NO	.100	99.975	NO
TIN	NO	.025	100.000	NO
ALUMINUM	NO	0.000	100.000	
CESIUM	NO	0.000	100.000	
COBALT	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
SILICON	NO	0.000	100.000	
CALCIUM		0.000		
IRON		0.000		
MAGNESIUM		0.000		
MERCURY		0.000		
MOLYBDENUM		0.000		
POTASSIUM		0.000		
SILVER		0.000		
SODIUM		0.000		
THALLIUM		0.000		

IHSS 201: Standley Lake

MANGANESE	YES	43.710	43.710	NO
ARSENIC	YES	39.434	83.144	YES
STRONTIUM	YES	6.642	89.786	NO
MOLYBDENUM	YES	6.351	96.137	NO
BARIUM	YES	1.712	97.849	NO
CHROMIUM	YES	1.557	99.406	NO
COPPER	NO	.381	99.787	NO
ZINC	NO	.213	100.000	NO
ALUMINUM	NO	0.000	100.000	
LEAD	NO	0.000	100.000	
LITHIUM	NO	0.000	100.000	
SILICON	NO	0.000	100.000	
ANTIMONY		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RfD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

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Table D-9b  
Total Non-radionuclides - Groundwater  
(Noncarcinogenic Effects)

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Chemical Name	Upper 99% of Risk	Percent of Risk (1)	Cumulative Percent of Risk	Exceeds PRG (2)
IHSS 201: Standley Lake				
BERYLLIUM		0.000		
CADMIUM		0.000		
CALCIUM		0.000		
CESIUM		0.000		
COBALT		0.000		
IRON		0.000		
MAGNESIUM		0.000		
MERCURY		0.000		
NICKEL		0.000		
POTASSIUM		0.000		
SELENIUM		0.000		
SILVER		0.000		
SODIUM		0.000		
THALLIUM		0.000		
TIN		0.000		
VANADIUM		0.000		

NOTES: (1) A value of zero signifies that no toxicity value (SF or RFD) exists in IRIS or HEAST.  
(2) See Appendix E for calculation methodology and specific PRG values.

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## APPENDIX E. PRG COMPARISON RESULTS

Appendix E contains results of the PRG comparison for chemicals considered likely to contribute significantly to the overall risk. The PRGs used in this step are equivalent to the RBCs described in Subsection 3.4, and were calculated based on the methodology presented in Programmatic Preliminary Remediation Goals (DOE, 1994). This document is included in Appendix E as Attachment 1. The following table summarizes the exposure scenarios and pathways on which the PRGs are based.

### SUMMARY OF EXPOSURE SCENARIOS AND PATHWAYS ROCKY FLATS OPERABLE UNIT 3

Media	Exposure Scenario	Pathway
Surface Soil	Residential	Direct Ingestion of Soils <sup>a</sup> Inhalation of Particulates <sup>a</sup> External Radiation Exposure <sup>b</sup>
Surface Sediment	Residential	Direct Ingestion of Soils <sup>a</sup> Inhalation of Particulates <sup>a</sup> External Radiation Exposure <sup>b</sup>
Subsurface Sediment	Construction Worker	Direct Ingestion of Soils <sup>a</sup> Inhalation of Particulates <sup>a</sup> External Radiation Exposure <sup>b</sup>
Surface Water	Residential	Direct Ingestion While Swimming <sup>a</sup>
Groundwater	Residential	Direct Ingestion of Groundwater <sup>a</sup> Inhalation During Domestic Use <sup>c</sup>

Notes:

- <sup>a</sup> Includes assessment of organics, inorganics, and radionuclides.
- <sup>b</sup> Includes assessment of radionuclides.
- <sup>c</sup> Includes assessment of volatile organics.

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Tables E-1 through E-9 summarize the comparison of PRG values to OU 3 data for sediments, surface water, and groundwater. The comparisons for each analyte by IHSS and media type presented in Tables E-1 through E-8 include maximum detected value, PRG based on carcinogenic risk (if applicable), and PRG based on non-carcinogenic effects (if applicable). Table E-9 summarizes the PRG screen results for those chemicals not screened out by the concentration-toxicity screen and identifies the analytes by media and IHSS that exceed the PRG.

The following is a list of PRG comparison results grouped by media, analyte, and IHSS. Please note that *subsurface* sediment data is presented only for Great Western Reservoir (IHSS 200):

- Table E-1 – Total Radionuclide PRG Values for Surface Sediments (Grab Samples)
- Table E-2 – Total Non-radionuclide PRG Values for Surface Sediments (Grab Samples)
- Table E-3 – Total Radionuclide PRG Values for Subsurface Sediments (Core Samples)
- Table E-4 – Total Non-radionuclide PRG Values for Subsurface Sediments (Core Samples)
- Table E-5 – Total Radionuclide PRG Values for Surface Water
- Table E-6 – Total Non-radionuclide PRG Values for Surface Water
- Table E-7 – Total Radionuclide PRG Values for Groundwater
- Table E-8 – Total Non-radionuclide PRG Values for Groundwater
- Table E-9 – PRG Screen Results

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## REFERENCES

DOE, 1994. United States Department of Energy. Draft Final Rocky Flats Programmatic Preliminary Remediation Goals. Golden, Colorado. June 1994.

Table E-1

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Total Radionuclide PRG Values for Surface Sediments (Grab Samples)

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Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 200: Great Western Reservoir				
AMERICIUM-241	PCI/G	2.060e-001	2.373e+000	
CESIUM-137	PCI/G	5.700e-001	2.834e+001	
PLUTONIUM-239/240	PCI/G	3.300e+000	3.425e+000	
RADIUM-226	PCI/G	2.200e+000	2.276e+000	
RADIUM-228	PCI/G	2.200e+000	7.935e+000	
STRONTIUM-89/90	PCI/G	5.700e-001	1.892e+001	
TRITIUM	PCI/L	8.087e-001	1.470e+004	
URANIUM-233/234	PCI/G	5.400e+000	4.533e+001	
URANIUM-235	PCI/G	5.600e-001	1.730e-001	
URANIUM-238	PCI/G	4.400e+000	4.597e+001	
IHSS 201: Standley Lake				
AMERICIUM-241	PCI/G	1.070e-001	2.373e+000	
CESIUM-137	PCI/G	5.500e-002	2.834e+001	
PLUTONIUM-239/240	PCI/G	5.530e-001	3.425e+000	
RADIUM-226	PCI/G	1.400e+000	2.276e+000	
RADIUM-228	PCI/G	1.600e+000	7.935e+000	
STRONTIUM-89/90	PCI/G	7.200e-001	1.892e+001	
TRITIUM	PCI/L	8.718e-002	1.470e+004	
URANIUM-233/234	PCI/G	4.700e+000	4.533e+001	
URANIUM-235	PCI/G	2.000e-001	1.730e-001	
URANIUM-238	PCI/G	3.900e+000	4.597e+001	
IHSS 202: Mower Reservoir				
AMERICIUM-241	PCI/G	9.288e-002	2.373e+000	
PLUTONIUM-239/240	PCI/G	4.879e-001	3.425e+000	
URANIUM-233/234	PCI/G	3.500e+000	4.533e+001	
URANIUM-235	PCI/G	1.700e-001	1.730e-001	
URANIUM-238	PCI/G	3.300e+000	4.597e+001	

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Table E-2

8/29/94 Total Non-radionuclide PRG Values for Surface Sediments (Grab Samples) Page E-2

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 200: Great Western Reservoir				
ALUMINUM	MG/KG	2.080e+004		
ANTIMONY	MG/KG	1.320e+001		1.098e+002
ARSENIC	MG/KG	9.400e+000	3.659e-001	8.233e+001
BARIUM	MG/KG	2.430e+002		1.906e+004
BERYLLIUM	MG/KG	1.600e+000	1.489e-001	1.372e+003
CADMIUM	MG/KG	1.700e+000	6.259e+003	1.372e+002
CALCIUM	MG/KG	3.390e+004		
CESIUM	MG/KG	2.970e+001		
CHROMIUM	MG/KG	1.980e+001	9.617e+002	1.372e+003
COBALT	MG/KG	2.330e+001		
COPPER	MG/KG	1.290e+002		1.098e+004
CYANIDE	MG/KG			
IRON	MG/KG	5.390e+004		
LEAD	MG/KG	8.820e+001		
LITHIUM	MG/KG	1.760e+001		
MAGNESIUM	MG/KG	5.140e+003		
MANGANESE	MG/KG	1.550e+003		1.364e+003
MERCURY	MG/KG	2.000e-001		8.233e+001
MOLYBDENUM	MG/KG	1.790e+001		1.372e+003
NICKEL	MG/KG	7.270e+001		5.489e+003
POTASSIUM	MG/KG	2.700e+003		
SELENIUM	MG/KG	4.000e+000		1.372e+003
SILICON	MG/KG	1.020e+003		
SILVER	MG/KG	6.000e+000		1.372e+003
SODIUM	MG/KG	2.490e+003		
STRONTIUM	MG/KG	1.540e+002		1.647e+005
THALLIUM	MG/KG	9.500e-001		
TIN	MG/KG	6.100e+000		1.647e+005
VANADIUM	MG/KG	8.770e+001		1.921e+003
ZINC	MG/KG	5.400e+002		8.233e+004

## IHSS 201: Standley Lake

ALUMINUM	MG/KG	3.320e+004		
ANTIMONY	MG/KG	6.900e+000		1.098e+002
ARSENIC	MG/KG	1.770e+001	3.659e-001	8.233e+001
BARIUM	MG/KG	3.290e+002		1.906e+004
BERYLLIUM	MG/KG	1.600e+000	1.489e-001	1.372e+003
CADMIUM	MG/KG	6.300e+000	6.259e+003	1.372e+002
CALCIUM	MG/KG	9.010e+004		
CESIUM	MG/KG	1.990e+001		
CHROMIUM	MG/KG	3.190e+001	9.617e+002	1.372e+003
COBALT	MG/KG	1.320e+001		
COPPER	MG/KG	1.830e+002		1.098e+004
IRON	MG/KG	2.830e+004		

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Table E-2

8/29/94 Total Non-radionuclide PRG Values for Surface Sediments (Grab Samples) Page E-3

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 201: Standley Lake				
LEAD	MG/KG	3.170e+002		
LITHIUM	MG/KG	3.460e+001		
MAGNESIUM	MG/KG	9.480e+003		
MANGANESE	MG/KG	4.450e+003		1.364e+003
MERCURY	MG/KG	6.000e-001		8.233e+001
MOLYBDENUM	MG/KG	7.700e+000		1.372e+003
NICKEL	MG/KG	2.370e+001		5.489e+003
POTASSIUM	MG/KG	8.390e+003		
SELENIUM	MG/KG	4.500e+000		1.372e+003
SILICON	MG/KG	3.290e+003		
SILVER	MG/KG	7.700e+000		1.372e+003
SODIUM	MG/KG	1.610e+003		
STRONTIUM	MG/KG	4.230e+002		1.647e+005
THALLIUM	MG/KG	3.800e-001		
TIN	MG/KG	1.040e+001		1.647e+005
VANADIUM	MG/KG	6.090e+001		1.921e+003
ZINC	MG/KG	1.170e+003		8.233e+004

## IHSS 202: Mower Reservoir

1,1,1-TRICHLOROETHANE	MG/KG	0.000e+000		
1,1,2,2-TETRACHLOROETHANE	MG/KG	0.000e+000		
1,1,2-TRICHLOROETHANE	MG/KG	0.000e+000		
1,1-DICHLOROETHANE	MG/KG	0.000e+000		
1,1-DICHLOROETHENE	MG/KG	0.000e+000		
1,2-DICHLOROETHANE	MG/KG	0.000e+000		
1,2-DICHLOROETHENE	MG/KG	0.000e+000		
1,2-DICHLOROPROPANE	MG/KG	0.000e+000		
2-BUTANONE	MG/KG	1.400e-002		1.647e+005
2-HEXANONE	MG/KG	0.000e+000		
4-METHYL-2-PENTANONE	MG/KG	0.000e+000		
ACETONE	MG/KG	4.700e-002		2.744e+004
ALUMINUM	MG/KG	1.830e+004		
ANTIMONY	MG/KG	1.730e+001		1.098e+002
ARSENIC	MG/KG	1.040e+001	3.659e-001	8.233e+001
BARIUM	MG/KG	2.960e+002		1.906e+004
BENZENE	MG/KG	0.000e+000		
BERYLLIUM	MG/KG	1.500e+000	1.489e-001	1.372e+003
BROMODICHLOROMETHANE	MG/KG	0.000e+000		
BROMOFORM	MG/KG	0.000e+000		
BROMOMETHANE	MG/KG	0.000e+000		
CADMIUM	MG/KG			
CALCIUM	MG/KG	5.940e+004		
CARBON DISULFIDE	MG/KG	0.000e+000		
CARBON TETRACHLORIDE	MG/KG	0.000e+000		

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Table E-2

8/29/94 Total Non-radionuclide PRG Values for Surface Sediments (Grab Samples) Page E-4

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 202: Mower Reservoir				
CESIUM	MG/KG	6.980e+001		
CHLOROBENZENE	MG/KG	0.000e+000		
CHLOROETHANE	MG/KG	0.000e+000		
CHLOROFORM	MG/KG	0.000e+000		
CHLOROMETHANE	MG/KG	0.000e+000		
CHROMIUM	MG/KG	2.210e+001	9.617e+002	1.372e+003
CIS-1,3-DICHLOROPROPENE	MG/KG	0.000e+000		
COBALT	MG/KG	1.530e+001		
COPPER	MG/KG	5.010e+001		1.098e+004
CYANIDE	MG/KG			
DIBROMOCHLOROMETHANE	MG/KG	0.000e+000		
ETHYLBENZENE	MG/KG	0.000e+000		
IRON	MG/KG	4.800e+004		
LEAD	MG/KG	4.080e+001		
LITHIUM	MG/KG	1.620e+001		
MAGNESIUM	MG/KG	5.040e+003		
MANGANESE	MG/KG	1.170e+003		1.364e+003
MERCURY	MG/KG	1.000e-001		8.233e+001
METHYLENE CHLORIDE	MG/KG	5.000e-003	8.538e+001	1.647e+004
MOLYBDENUM	MG/KG			
NICKEL	MG/KG	2.920e+001		5.489e+003
POTASSIUM	MG/KG	3.450e+003		
SELENIUM	MG/KG	5.700e+000		1.372e+003
SILICON	MG/KG	4.120e+002		
SILVER	MG/KG	1.900e+000		1.372e+003
SODIUM	MG/KG	1.080e+003		
STRONTIUM	MG/KG	3.490e+002		1.647e+005
STYRENE	MG/KG	0.000e+000		
TETRACHLOROETHENE	MG/KG	0.000e+000		
THALLIUM	MG/KG	2.500e-001		
TIN	MG/KG	5.140e+001		1.647e+005
TOLUENE	MG/KG	1.600e-002		5.489e+004
TOTAL XYLENES	MG/KG	2.000e-003		5.489e+005
TRANS-1,3-DICHLOROPROPENE	MG/KG	0.000e+000		
TRICHLOROETHENE	MG/KG	0.000e+000		
TRICHLOROTRIFLUOROETHANE	MG/KG	5.000e-002		8.233e+006
UNKNOWN	MG/KG	9.000e-003		
UNKNOWN-1	MG/KG	9.000e-003		
UNKNOWN-2	MG/KG	2.400e-002		
VANADIUM	MG/KG	1.140e+002		1.921e+003
VINYL ACETATE	MG/KG	0.000e+000		
VINYL CHLORIDE	MG/KG	0.000e+000		
ZINC	MG/KG	1.930e+002		8.233e+004

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Table E-3

8/29/94 Total Radionuclide PRG Values for Subsurface Sediments (Core Samples) Page E-5

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 200: Great Western Reservoir				
AMERICIUM-241	PCI/G	1.016e+000	6.505e+002	
PLUTONIUM-239/240	PCI/G	4.030e+000	2.851e+003	
POLONIUM-210	PCI/G	3.140e+000	4.309e+003	
URANIUM-233/234	PCI/G	3.900e+000	3.094e+004	
URANIUM-235	PCI/G	2.100e-001	1.735e+001	
URANIUM-238	PCI/G	3.300e+000	3.325e+004	

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Table E-4

8/29/94 Total Non-radionuclide PRG Values for Subsurface Sediments (Core Samples) Page E-6

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 200: Great Western Reservoir				
ALUMINUM	MG/KG	2.610e+004		
ARSENIC	MG/KG	1.040e+001	6.812e+002	5.110e+003
BARIUM	MG/KG	2.050e+002		1.176e+006
BERYLLIUM	MG/KG	2.300e+000	2.773e+002	8.517e+004
CADMIUM	MG/KG	2.600e+000	6.598e+006	8.517e+003
CALCIUM	MG/KG	1.540e+004		
CESIUM	MG/KG	3.920e+001		
CHROMIUM	MG/KG	2.810e+001	1.014e+006	8.517e+004
COBALT	MG/KG	1.220e+001		
COPPER	MG/KG	3.110e+002		6.813e+005
IRON	MG/KG	2.560e+004		
LEAD	MG/KG	1.260e+002		
LITHIUM	MG/KG	1.960e+001		
MAGNESIUM	MG/KG	5.080e+003		
MANGANESE	MG/KG	7.720e+002		8.432e+004
MERCURY	MG/KG	3.000e-001		5.109e+003
MOLYBDENUM	MG/KG	5.000e+000		8.517e+004
NICKEL	MG/KG	2.360e+001		3.407e+005
POTASSIUM	MG/KG	4.000e+003		
SELENIUM	MG/KG	2.450e+000		8.517e+004
SILVER	MG/KG	1.650e+001		8.517e+004
SODIUM	MG/KG	2.240e+002		
STRONTIUM	MG/KG	8.840e+001		1.022e+007
THALLIUM	MG/KG			
TIN	MG/KG	6.000e+000		1.022e+007
VANADIUM	MG/KG	6.040e+001		1.192e+005
ZINC	MG/KG	4.800e+002		5.110e+006

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 200: Great Western Reservoir				
AMERICIUM-241	PCI/L	1.717e-002	1.526e+002	
PLUTONIUM-239/240	PCI/L	5.000e-003	1.593e+002	
TRITIUM	PCI/L	1.443e+002	6.783e+005	
URANIUM-233/234	PCI/L	1.200e+000	2.289e+003	
URANIUM-235	PCI/L	4.100e-001	2.289e+003	
URANIUM-238	PCI/L	8.700e-001	2.289e+003	
IHSS 201: Standley Lake				
AMERICIUM-241	PCI/L	2.600e-002	1.526e+002	
PLUTONIUM-239/240	PCI/L	8.990e-003	1.593e+002	
URANIUM-233/234	PCI/L	1.300e+000	2.289e+003	
URANIUM-235	PCI/L	2.700e-001	2.289e+003	
URANIUM-238	PCI/L	1.100e+000	2.289e+003	
IHSS 202: Mower Reservoir				
AMERICIUM-241	PCI/L	1.700e-002	1.526e+002	
PLUTONIUM-239/240	PCI/L	3.000e-002	1.593e+002	
URANIUM-233/234	PCI/L	8.200e-001	2.289e+003	
URANIUM-235	PCI/L	1.450e-001	2.289e+003	
URANIUM-238	PCI/L	6.500e-001	2.289e+003	

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 200: Great Western Reservoir				
ALUMINUM	UG/L	4.260e+003	0.000e+000	0.000e+000
AMETRYN	UG/L	0.000e+000	0.000e+000	0.000e+000
ANTIMONY	UG/L	0.000e+000	0.000e+000	0.000e+000
ARSENIC	UG/L	2.900e+000	3.744e+001	8.423e+003
ATRATON	UG/L	0.000e+000	0.000e+000	0.000e+000
ATRAZINE	UG/L	0.000e+000	0.000e+000	0.000e+000
BARIUM	UG/L	8.010e+001	0.000e+000	1.965e+006
BERYLLIUM	UG/L	4.000e-001	1.524e+001	1.404e+005
CADMIUM	UG/L	2.800e+000	0.000e+000	1.404e+004
CALCIUM	UG/L	4.720e+004	0.000e+000	0.000e+000
CESIUM	UG/L	9.000e+001	0.000e+000	0.000e+000
CHROMIUM	UG/L	4.400e+000	0.000e+000	1.404e+005
COBALT	UG/L	2.600e+000	0.000e+000	0.000e+000
COPPER	UG/L	2.090e+001	0.000e+000	1.123e+006
CYANIDE	UG/L	0.000e+000	0.000e+000	0.000e+000
IRON	UG/L	2.340e+003	0.000e+000	0.000e+000
LEAD	UG/L	1.850e+001	0.000e+000	0.000e+000
LITHIUM	UG/L	8.700e+000	0.000e+000	0.000e+000
MAGNESIUM	UG/L	1.110e+004	0.000e+000	0.000e+000
MANGANESE	UG/L	2.100e+002	0.000e+000	1.404e+005
MERCURY	UG/L	0.000e+000	0.000e+000	0.000e+000
MOLYBDENUM	UG/L	8.200e+000	0.000e+000	1.404e+005
NICKEL	UG/L	6.500e+000	0.000e+000	5.615e+005
POTASSIUM	UG/L	6.390e+003	0.000e+000	0.000e+000
PROMETON	UG/L	0.000e+000	0.000e+000	0.000e+000
PROMETRYN	UG/L	0.000e+000	0.000e+000	0.000e+000
PROPAZINE	UG/L	0.000e+000	0.000e+000	0.000e+000
SELENIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
SILICON	UG/L	7.770e+003	0.000e+000	0.000e+000
SILVER	UG/L	0.000e+000	0.000e+000	0.000e+000
SIMAZINE	UG/L	0.000e+000	0.000e+000	0.000e+000
SIMETRYN	UG/L	0.000e+000	0.000e+000	0.000e+000
SODIUM	UG/L	4.000e+004	0.000e+000	0.000e+000
STRONTIUM	UG/L	3.060e+002	0.000e+000	1.685e+007
TERBUTHYLAZINE	UG/L	0.000e+000	0.000e+000	0.000e+000
TERBUTRYN	UG/L	0.000e+000	0.000e+000	0.000e+000
THALLIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
TIN	UG/L	9.700e+000	0.000e+000	1.685e+007
VANADIUM	UG/L	8.000e+000	0.000e+000	1.965e+005
ZINC	UG/L	1.580e+002	0.000e+000	8.423e+006

## IHSS 201: Standley Lake

ALUMINUM	UG/L	1.540e+003	0.000e+000	0.000e+000
ANTIMONY	UG/L	0.000e+000	0.000e+000	0.000e+000

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units Detected	Maximum Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 201: Standley Lake				
ARSENIC	UG/L	0.000e+000	0.000e+000	0.000e+000
ATRAZINE	UG/L	0.000e+000	0.000e+000	0.000e+000
BARIUM	UG/L	4.450e+001	0.000e+000	1.965e+006
BERYLLIUM	UG/L	3.600e-001	1.524e+001	1.404e+005
CADMIUM	UG/L	2.400e+000	0.000e+000	1.404e+004
CALCIUM	UG/L	2.610e+004	0.000e+000	0.000e+000
CESIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
CHROMIUM	UG/L	2.900e+000	0.000e+000	1.404e+005
COBALT	UG/L	1.900e+000	0.000e+000	0.000e+000
COPPER	UG/L	1.650e+001	0.000e+000	1.123e+006
CYANIDE	UG/L	2.150e+001	0.000e+000	5.615e+005
IRON	UG/L	1.150e+003	0.000e+000	0.000e+000
LEAD	UG/L	1.070e+001	0.000e+000	0.000e+000
LITHIUM	UG/L	1.110e+001	0.000e+000	0.000e+000
MAGNESIUM	UG/L	6.480e+003	0.000e+000	0.000e+000
MANGANESE	UG/L	1.580e+003	0.000e+000	1.404e+005
MERCURY	UG/L	8.200e-001	0.000e+000	8.423e+003
MOLYBDENUM	UG/L	7.700e+000	0.000e+000	1.404e+005
NICKEL	UG/L	3.310e+001	0.000e+000	5.615e+005
POTASSIUM	UG/L	2.370e+003	0.000e+000	0.000e+000
SELENIUM	UG/L	5.300e+000	0.000e+000	1.404e+005
SILICON	UG/L	4.040e+003	0.000e+000	0.000e+000
SILVER	UG/L	0.000e+000	0.000e+000	0.000e+000
SIMAZINE	UG/L	0.000e+000	0.000e+000	0.000e+000
SODIUM	UG/L	4.150e+005	0.000e+000	0.000e+000
STRONTIUM	UG/L	1.860e+002	0.000e+000	1.685e+007
THALLIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
TIN	UG/L	0.000e+000	0.000e+000	0.000e+000
VANADIUM	UG/L	3.800e+000	0.000e+000	1.965e+005
ZINC	UG/L	1.840e+002	0.000e+000	8.423e+006

## IHSS 202: Mower Reservoir

1,1,1-TRICHLOROETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
1,1,2,2-TETRACHLOROETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
1,1,2-TRICHLOROETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
1,1-DICHLOROETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
1,1-DICHLOROETHENE	UG/L	0.000e+000	0.000e+000	0.000e+000
1,2-DICHLOROETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
1,2-DICHLOROETHENE	UG/L	0.000e+000	0.000e+000	0.000e+000
1,2-DICHLOROPROPANE	UG/L	0.000e+000	0.000e+000	0.000e+000
2-BUTANONE	UG/L	0.000e+000	0.000e+000	0.000e+000
2-HEXANONE	UG/L	0.000e+000	0.000e+000	0.000e+000
4-METHYL-2-PENTANONE	UG/L	0.000e+000	0.000e+000	0.000e+000
ACETONE	UG/L	0.000e+000	0.000e+000	0.000e+000

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 202: Mower Reservoir				
ALUMINUM	UG/L	1.960e+002	0.000e+000	0.000e+000
ANTIMONY	UG/L	0.000e+000	0.000e+000	0.000e+000
ARSENIC	UG/L	6.600e+000	3.744e+001	8.423e+003
ATRAZINE	UG/L	0.000e+000	0.000e+000	0.000e+000
BARIUM	UG/L	3.470e+001	0.000e+000	1.965e+006
BENZENE	UG/L	0.000e+000	0.000e+000	0.000e+000
BERYLLIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
BROMODICHLOROMETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
BROMOFORM	UG/L	0.000e+000	0.000e+000	0.000e+000
BROMOMETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
CADMIUM	UG/L	9.000e+000	0.000e+000	1.404e+004
CALCIUM	UG/L	1.390e+004	0.000e+000	0.000e+000
CARBON DISULFIDE	UG/L	0.000e+000	0.000e+000	0.000e+000
CARBON TETRACHLORIDE	UG/L	0.000e+000	0.000e+000	0.000e+000
CESIUM	UG/L	8.000e+001	0.000e+000	0.000e+000
CHLOROBENZENE	UG/L	0.000e+000	0.000e+000	0.000e+000
CHLOROETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
CHLOROFORM	UG/L	0.000e+000	0.000e+000	0.000e+000
CHLOROMETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
CHROMIUM	UG/L	6.580e+001	0.000e+000	1.404e+005
CIS-1,3-DICHLOROPROPENE	UG/L	0.000e+000	0.000e+000	0.000e+000
COBALT	UG/L	0.000e+000	0.000e+000	0.000e+000
COPPER	UG/L	4.500e+000	0.000e+000	1.123e+006
CYANIDE	UG/L	0.000e+000	0.000e+000	0.000e+000
DIBROMOCHLOROMETHANE	UG/L	0.000e+000	0.000e+000	0.000e+000
ETHYLBENZENE	UG/L	0.000e+000	0.000e+000	0.000e+000
IRON	UG/L	3.280e+002	0.000e+000	0.000e+000
LEAD	UG/L	3.720e+001	0.000e+000	0.000e+000
LITHIUM	UG/L	9.400e+000	0.000e+000	0.000e+000
MAGNESIUM	UG/L	7.340e+003	0.000e+000	0.000e+000
MANGANESE	UG/L	3.700e+001	0.000e+000	1.404e+005
MERCURY	UG/L	3.000e-001	0.000e+000	8.423e+003
METHYLENE CHLORIDE	UG/L	0.000e+000	0.000e+000	0.000e+000
MOLYBDENUM	UG/L	4.400e+000	0.000e+000	1.404e+005
NICKEL	UG/L	2.300e+001	0.000e+000	5.615e+005
POTASSIUM	UG/L	7.400e+002	0.000e+000	0.000e+000
SELENIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
SILICON	UG/L	3.250e+003	0.000e+000	0.000e+000
SILVER	UG/L	0.000e+000	0.000e+000	0.000e+000
SIMAZINE	UG/L	0.000e+000	0.000e+000	0.000e+000
SODIUM	UG/L	3.120e+004	0.000e+000	0.000e+000
STRONTIUM	UG/L	1.320e+002	0.000e+000	1.685e+007
STYRENE	UG/L	0.000e+000	0.000e+000	0.000e+000
TETRACHLOROETHENE	UG/L	0.000e+000	0.000e+000	0.000e+000
THALLIUM	UG/L	0.000e+000	0.000e+000	0.000e+000

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units	Detected Value	Maximum Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
-----					
IHSS 202: Mower Reservoir					
TIN	UG/L	6.500e+000	6.500e+000	0.000e+000	1.685e+007
TOLUENE	UG/L	0.000e+000	0.000e+000	0.000e+000	0.000e+000
TOTAL XYLENES	UG/L	0.000e+000	0.000e+000	0.000e+000	0.000e+000
TRANS-1,3-DICHLOROPROPENE	UG/L	0.000e+000	0.000e+000	0.000e+000	0.000e+000
TRICHLOROETHENE	UG/L	0.000e+000	0.000e+000	0.000e+000	0.000e+000
VANADIUM	UG/L	6.400e+000	6.400e+000	0.000e+000	1.965e+005
VINYL ACETATE	UG/L	0.000e+000	0.000e+000	0.000e+000	0.000e+000
VINYL CHLORIDE	UG/L	0.000e+000	0.000e+000	0.000e+000	0.000e+000
ZINC	UG/L	1.800e+001	1.800e+001	0.000e+000	8.423e+006

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
-----				
IHSS 200: Great Western Reservoir				
AMERICIUM-241	PCI/L	2.100e-002	1.984e-001	
PLUTONIUM-239/240	PCI/L	8.500e-002	2.070e-001	
URANIUM-233/234	PCI/L	4.600e+000	2.976e+000	
URANIUM-235	PCI/L	2.000e-001	2.976e+000	
URANIUM-238	PCI/L	4.200e+000	2.976e+000	
IHSS 201: Standley Lake				
AMERICIUM-241	PCI/L	1.000e-002	1.984e-001	
PLUTONIUM-239/240	PCI/L	1.000e-003	2.070e-001	
URANIUM-233/234	PCI/L	8.700e-001	2.976e+000	
URANIUM-235	PCI/L	8.300e-002	2.976e+000	
URANIUM-238	PCI/L	9.100e-001	2.976e+000	

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
IHSS 200: Great Western Reservoir				
ALUMINUM	UG/L	2.340e+004	0.000e+000	0.000e+000
ANTIMONY	UG/L	2.750e+001	0.000e+000	1.460e+001
ARSENIC	UG/L	6.900e+000	4.867e-002	1.095e+001
BARIUM	UG/L	1.660e+002	0.000e+000	2.555e+003
BERYLLIUM	UG/L	1.600e+000	1.981e-002	1.825e+002
CADMIUM	UG/L	2.800e+000	0.000e+000	1.825e+001
CALCIUM	UG/L	3.520e+005	0.000e+000	0.000e+000
CESIUM	UG/L	5.000e+001	0.000e+000	0.000e+000
CHROMIUM	UG/L	2.900e+001	0.000e+000	1.825e+002
COBALT	UG/L	1.660e+001	0.000e+000	0.000e+000
COPPER	UG/L	3.970e+001	0.000e+000	1.460e+003
IRON	UG/L	2.710e+004	0.000e+000	0.000e+000
LEAD	UG/L	2.010e+001	0.000e+000	0.000e+000
LITHIUM	UG/L	4.650e+002	0.000e+000	0.000e+000
MAGNESIUM	UG/L	9.770e+004	0.000e+000	0.000e+000
MANGANESE	UG/L	9.590e+002	0.000e+000	1.825e+002
MERCURY	UG/L	0.000e+000	0.000e+000	0.000e+000
MOLYBDENUM	UG/L	0.000e+000	0.000e+000	0.000e+000
NICKEL	UG/L	3.030e+001	0.000e+000	7.300e+002
POTASSIUM	UG/L	1.480e+004	0.000e+000	0.000e+000
SELENIUM	UG/L	1.600e+000	0.000e+000	1.825e+002
SILICON	UG/L	5.360e+004	0.000e+000	0.000e+000
SILVER	UG/L	0.000e+000	0.000e+000	0.000e+000
SODIUM	UG/L	5.330e+005	0.000e+000	0.000e+000
STRONTIUM	UG/L	5.590e+003	0.000e+000	2.190e+004
THALLIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
TIN	UG/L	4.780e+001	0.000e+000	2.190e+004
VANADIUM	UG/L	7.020e+001	0.000e+000	2.555e+002
ZINC	UG/L	1.580e+002	0.000e+000	1.095e+004

## IHSS 201: Standley Lake

ALUMINUM	UG/L	3.380e+002	0.000e+000	0.000e+000
ANTIMONY	UG/L	0.000e+000	0.000e+000	0.000e+000
ARSENIC	UG/L	3.800e+000	4.867e-002	1.095e+001
BARIUM	UG/L	3.850e+001	0.000e+000	2.555e+003
BERYLLIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
CADMIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
CALCIUM	UG/L	9.910e+004	0.000e+000	0.000e+000
CESIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
CHROMIUM	UG/L	2.500e+000	0.000e+000	1.825e+002
COBALT	UG/L	0.000e+000	0.000e+000	0.000e+000
COPPER	UG/L	4.900e+000	0.000e+000	1.460e+003
IRON	UG/L	1.300e+003	0.000e+000	0.000e+000
LEAD	UG/L	1.700e+000	0.000e+000	0.000e+000

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects
-----				
IHSS 201: Standley Lake				
LITHIUM	UG/L	7.860e+001	0.000e+000	0.000e+000
MAGNESIUM	UG/L	2.430e+004	0.000e+000	0.000e+000
MANGANESE	UG/L	7.020e+001	0.000e+000	1.825e+002
MERCURY	UG/L	0.000e+000	0.000e+000	0.000e+000
MOLYBDENUM	UG/L	1.020e+001	0.000e+000	1.825e+002
NICKEL	UG/L	0.000e+000	0.000e+000	0.000e+000
POTASSIUM	UG/L	3.830e+003	0.000e+000	0.000e+000
SELENIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
SILICON	UG/L	6.260e+003	0.000e+000	0.000e+000
SILVER	UG/L	0.000e+000	0.000e+000	0.000e+000
SODIUM	UG/L	2.680e+005	0.000e+000	0.000e+000
STRONTIUM	UG/L	1.280e+003	0.000e+000	2.190e+004
THALLIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
TIN	UG/L	0.000e+000	0.000e+000	0.000e+000
VANADIUM	UG/L	0.000e+000	0.000e+000	0.000e+000
ZINC	UG/L	2.050e+001	0.000e+000	1.095e+004

NOTES: PRG=Preliminary Remediation Goal.

Chemicals in this table have not passed through the previous steps of the COC selection process.

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects	Exceeds PRG
Surface Sediments					
IHSS 200: Great Western Reservoir					
AMERICIUM-241	PCI/G	2.060e-001	2.373e+000		NO
PLUTONIUM-239/240	PCI/G	3.300e+000	3.425e+000		NO
RADIUM-226	PCI/G	2.200e+000	2.276e+000		NO
URANIUM-233/234	PCI/G	5.400e+000	4.533e+001		NO
URANIUM-235	PCI/G	5.600e-001	1.730e-001		YES
URANIUM-238	PCI/G	4.400e+000	4.597e+001		NO
ARSENIC	MG/KG	9.400e+000	3.659e-001	8.233e+001	YES
BARIIUM	MG/KG	2.430e+002		1.906e+004	NO
BERYLLIUM	MG/KG	1.600e+000	1.489e-001	1.372e+003	YES
CADMIUM	MG/KG	1.700e+000	6.259e+003	1.372e+002	NO
CHROMIUM	MG/KG	1.980e+001	9.617e+002	1.372e+003	NO
MANGANESE	MG/KG	1.550e+003		1.364e+003	YES
IHSS 201: Standley Lake					
AMERICIUM-241	PCI/G	1.070e-001	2.373e+000		NO
PLUTONIUM-239/240	PCI/G	5.530e-001	3.425e+000		NO
RADIUM-226	PCI/G	1.400e+000	2.276e+000		NO
URANIUM-233/234	PCI/G	4.700e+000	4.533e+001		NO
URANIUM-235	PCI/G	2.000e-001	1.730e-001		YES
URANIUM-238	PCI/G	3.900e+000	4.597e+001		NO
ARSENIC	MG/KG	1.770e+001	3.659e-001	8.233e+001	YES
CADMIUM	MG/KG	6.300e+000	6.259e+003	1.372e+002	NO
CHROMIUM	MG/KG	3.190e+001	9.617e+002	1.372e+003	NO
MANGANESE	MG/KG	4.450e+003		1.364e+003	YES
IHSS 202: Mower Reservoir					
AMERICIUM-241	PCI/G	9.288e-002	2.373e+000		NO
PLUTONIUM-239/240	PCI/G	4.879e-001	3.425e+000		NO
URANIUM-233/234	PCI/G	3.500e+000	4.533e+001		NO
URANIUM-235	PCI/G	1.700e-001	1.730e-001		NO
URANIUM-238	PCI/G	3.300e+000	4.597e+001		NO
ARSENIC	MG/KG	1.040e+001	3.659e-001	8.233e+001	YES
BARIIUM	MG/KG	2.960e+002		1.906e+004	NO
BERYLLIUM	MG/KG	1.500e+000	1.489e-001	1.372e+003	YES
CHROMIUM	MG/KG	2.210e+001	9.617e+002	1.372e+003	NO
MANGANESE	MG/KG	1.170e+003		1.364e+003	NO

NOTES: PRG=Preliminary Remediation Goal.

The chemicals included in this table represent the upper 99% of the risk (as calculated by the concentration-toxicity screen), based on maximum concentrations.

Chemical Name	Units	Maximum Detected Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects	Exceeds PRG
Subsurface Sediments					
IHSS 200: Great Western Reservoir					
AMERICIUM-241	PCI/G	1.016e+000	6.505e+002		NO
PLUTONIUM-239/240	PCI/G	4.030e+000	2.851e+003		NO
POLONIUM-210	PCI/G	3.140e+000	4.309e+003		NO
URANIUM-233/234	PCI/G	3.900e+000	3.094e+004		NO
URANIUM-235	PCI/G	2.100e-001	1.735e+001		NO
URANIUM-238	PCI/G	3.300e+000	3.325e+004		NO
ARSENIC	MG/KG	1.040e+001	6.812e+002	5.110e+003	NO
BARIUM	MG/KG	2.050e+002		1.176e+006	NO
BERYLLIUM	MG/KG	2.300e+000	2.773e+002	8.517e+004	NO
CADMIUM	MG/KG	2.600e+000	6.598e+006	8.517e+003	NO
CHROMIUM	MG/KG	2.810e+001	1.014e+006	8.517e+004	NO
MANGANESE	MG/KG	7.720e+002		8.432e+004	NO
Surface Water					
IHSS 200: Great Western Reservoir					
AMERICIUM-241	PCI/L	1.717e-002	1.526e+002		NO
PLUTONIUM-239/240	PCI/L	5.000e-003	1.593e+002		NO
TRITIUM	PCI/L	1.443e+002	6.783e+005		NO
URANIUM-233/234	PCI/L	1.200e+000	2.289e+003		NO
URANIUM-235	PCI/L	4.100e-001	2.289e+003		NO
URANIUM-238	PCI/L	8.700e-001	2.289e+003		NO
ARSENIC	UG/L	2.900e+000	3.744e+001	8.423e+003	NO
BARIUM	UG/L	8.010e+001	0.000e+000	1.965e+006	NO
BERYLLIUM	UG/L	4.000e-001	1.524e+001	1.404e+005	NO
CADMIUM	UG/L	2.800e+000	0.000e+000	1.404e+004	NO
CHROMIUM	UG/L	4.400e+000	0.000e+000	1.404e+005	NO
COPPER	UG/L	2.090e+001	0.000e+000	1.123e+006	NO
MANGANESE	UG/L	2.100e+002	0.000e+000	1.404e+005	NO
MOLYBDENUM	UG/L	8.200e+000	0.000e+000	1.404e+005	NO
STRONTIUM	UG/L	3.060e+002	0.000e+000	1.685e+007	NO
VANADIUM	UG/L	8.000e+000	0.000e+000	1.965e+005	NO
ZINC	UG/L	1.580e+002	0.000e+000	8.423e+006	NO
IHSS 201: Standley Lake					
AMERICIUM-241	PCI/L	2.600e-002	1.526e+002		NO
PLUTONIUM-239/240	PCI/L	8.990e-003	1.593e+002		NO
URANIUM-233/234	PCI/L	1.300e+000	2.289e+003		NO
URANIUM-235	PCI/L	2.700e-001	2.289e+003		NO

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The chemicals included in this table represent the upper 99% of the risk (as calculated by the concentration-toxicity screen), based on maximum concentrations.

Chemical Name	Units Detected	Maximum Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects	Exceeds PRG
Surface Water					
IHSS 201: Standley Lake					
URANIUM-238	PCI/L	1.100e+000	2.289e+003		NO
BERYLLIUM	UG/L	3.600e-001	1.524e+001	1.404e+005	NO
CADMIUM	UG/L	2.400e+000	0.000e+000	1.404e+004	NO
CYANIDE	UG/L	2.150e+001	0.000e+000	5.615e+005	NO
MANGANESE	UG/L	1.580e+003	0.000e+000	1.404e+005	NO
MERCURY	UG/L	8.200e-001	0.000e+000	8.423e+003	NO
MOLYBDENUM	UG/L	7.700e+000	0.000e+000	1.404e+005	NO
NICKEL	UG/L	3.310e+001	0.000e+000	5.615e+005	NO
SELENIUM	UG/L	5.300e+000	0.000e+000	1.404e+005	NO
IHSS 202: Mower Reservoir					
AMERICIUM-241	PCI/L	1.700e-002	1.526e+002		NO
PLUTONIUM-239/240	PCI/L	3.000e-002	1.593e+002		NO
URANIUM-233/234	PCI/L	8.200e-001	2.289e+003		NO
URANIUM-235	PCI/L	1.450e-001	2.289e+003		NO
URANIUM-238	PCI/L	6.500e-001	2.289e+003		NO
ARSENIC	UG/L	6.600e+000	3.744e+001	8.423e+003	NO
BARIUM	UG/L	3.470e+001	0.000e+000	1.965e+006	NO
CADMIUM	UG/L	9.000e+000	0.000e+000	1.404e+004	NO
CHROMIUM	UG/L	6.580e+001	0.000e+000	1.404e+005	NO
MANGANESE	UG/L	3.700e+001	0.000e+000	1.404e+005	NO
MERCURY	UG/L	3.000e-001	0.000e+000	8.423e+003	NO
MOLYBDENUM	UG/L	4.400e+000	0.000e+000	1.404e+005	NO
NICKEL	UG/L	2.300e+001	0.000e+000	5.615e+005	NO
VANADIUM	UG/L	6.400e+000	0.000e+000	1.965e+005	NO
Groundwater					
IHSS 200: Great Western Reservoir					
AMERICIUM-241	PCI/L	2.100e-002	1.984e-001		NO
PLUTONIUM-239/240	PCI/L	8.500e-002	2.070e-001		NO
URANIUM-233/234	PCI/L	4.600e+000	2.976e+000		YES
URANIUM-235	PCI/L	2.000e-001	2.976e+000		NO
URANIUM-238	PCI/L	4.200e+000	2.976e+000		YES
ANTIMONY	UG/L	2.750e+001	0.000e+000	1.460e+001	YES
ARSENIC	UG/L	6.900e+000	4.867e-002	1.095e+001	YES
BARIUM	UG/L	1.660e+002	0.000e+000	2.555e+003	NO
BERYLLIUM	UG/L	1.600e+000	1.981e-002	1.825e+002	YES

NOTES: PRG=Preliminary Remediation Goal.

The chemicals included in this table represent the upper 99% of the risk (as calculated by the concentration-toxicity screen), based on maximum concentrations.

Chemical Name	Units Detected	Maximum Value	PRG Based on Carcinogenic Risk	PRG Based on Non-carcinogenic Effects	Excess PRG
Groundwater					
IHSS 200: Great Western Reservoir					
CADMIUM	UG/L	2.800e+000	0.000e+000	1.825e+001	NO
CHROMIUM	UG/L	2.900e+001	0.000e+000	1.825e+002	NO
MANGANESE	UG/L	9.590e+002	0.000e+000	1.825e+002	YES
NICKEL	UG/L	3.030e+001	0.000e+000	7.300e+002	NO
STRONTIUM	UG/L	5.590e+003	0.000e+000	2.190e+004	NO
VANADIUM	UG/L	7.020e+001	0.000e+000	2.555e+002	NO
IHSS 201: Standley Lake					
AMERICIUM-241	PCI/L	1.000e-002	1.984e-001		NO
URANIUM-233/234	PCI/L	8.700e-001	2.976e+000		NO
URANIUM-235	PCI/L	8.300e-002	2.976e+000		NO
URANIUM-238	PCI/L	9.100e-001	2.976e+000		NO
ARSENIC	UG/L	3.800e+000	4.867e-002	1.095e+001	YES
BARIUM	UG/L	3.850e+001	0.000e+000	2.555e+003	NO
CHROMIUM	UG/L	2.500e+000	0.000e+000	1.825e+002	NO
MANGANESE	UG/L	7.020e+001	0.000e+000	1.825e+002	NO
MOLYBDENUM	UG/L	1.020e+001	0.000e+000	1.825e+002	NO
STRONTIUM	UG/L	1.280e+003	0.000e+000	2.190e+004	NO

NOTES: PRG=Preliminary Remediation Goal.

The chemicals included in this table represent the upper 99% of the risk (as calculated by the concentration-toxicity screen), based on maximum concentrations.

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## LIST OF ACRONYMS

ACL	Alternative Concentration Limit
ARAR	Applicable or Relevant and Appropriate Requirement
BRA	Baseline Risk Assessment
CDH	Colorado Department of Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHWA	Colorado Hazardous Waste Act
CMS/FS	Corrective Measures Study/Feasibility Study
COC	Contaminant of Concern
DOE	U.S. Department of Energy
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OU	Operable Unit
PPRG	Programmatic Preliminary Remediation Goal
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFP	Rocky Flats Plant
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
TAL	Target Analyte List
TBC	To-Be-Considered
TCL	Target Compound List
USEPA	U.S. Environmental Protection Agency

## 1.0 INTRODUCTION

Various areas at the Rocky Flats Plant (RFP) are being closed and/or remediated in accordance with the provisions of the 1991 Interagency Agreement (IAG) signed between the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (USEPA), and the State of Colorado (IAG 1991) to ensure protection of human health and the environment. The IAG integrates the closure and corrective action provisions of the Resource Conservation and Recovery Act (RCRA) and the Colorado Hazardous Waste Act (CHWA) with the hazardous substance response requirements contained in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The various areas to be closed or remediated, called Individual Hazardous Substance Sites (IHSSs), are divided into 16 Operable Units (OUs).

DOE is in the process of conducting a RCRA Facility Investigation/Remedial Investigation (RFI/RI) and Corrective Measures Study/Feasibility Study (CMS/FS) for each OU to select the most appropriate remedy for each OU. In order to identify, evaluate, and select a remedial alternative, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) states that "Alternatives shall be developed that protect human health and the environment by recycling waste or by eliminating, reducing, and/or controlling risks posed through each pathway by a site." The number and type of alternatives to be analyzed shall be determined at each site, taking into account the scope, characteristics, and complexity of the site problem that is being addressed. In developing and, as appropriate, screening the alternatives, the lead agency shall establish remedial action objectives specifying contaminants and media of concern, potential exposure pathways, and remediation goals." [See 40 CFR 300.430(e)(2).]

This document addresses the establishment of programmatic remediation goals which are contaminant- and medium-specific levels of exposure that are protective of human health and the environment. The combination of the Baseline Risk Assessment (BRA) results, Applicable or Relevant and Appropriate Requirements (ARARs), and To-Be-Considered documents (TBCs) are used as the basis to establish the remediation goals approved by the regulatory agencies in the Record of Decision (ROD). CERCLA Section 121 and 40 CFR 300.430 allow the following factors to be considered when establishing remediation goals.

- Chemical-specific standards established pursuant to a Federal environmental law or any promulgated State standard which is more stringent than a Federal standard are to be used to establish remediation goals. These environmental laws include, but are not limited to, the Toxic Substances Control Act; the Safe Drinking Water Act; the Clean Air Act; the Clean Water Act; the Marine Protection, Research and Sanctuaries Act; and the Solid Waste Disposal Act. In addition to the promulgated standards, the following items should be considered:
  - For systemic toxicants, remediation goals are to be established so that the human population, including sensitive subgroups, may be exposed without adverse effect through a given lifetime (i.e., Hazard Index less than 1.0). Remediation goals are to incorporate an adequate margin of safety.

- For known or suspected carcinogens, remediation goals are to be established to represent an excess upper-bound lifetime cancer risk to an individual ranging from  $10^{-4}$  to  $10^{-6}$  using information on the relationship between dose and response. The  $10^{-6}$  risk level shall be used as the point of departure for determining remediation goals for alternatives where specific ARARs are not available or protective due to multiple contaminants or exposure pathways. [NOTE: In cases where the chemical-specific ARARs result in a cumulative risk in excess of  $10^{-4}$ , more restrictive remediation goals may be established in accordance with this provision.]
- Factors related to uncertainties, technical limitations (i.e., detection limits), and other pertinent information.
- Non-zero Maximum Contaminant Level Goals (MCLGs), where determined to be relevant and appropriate, are to be attained by remedial actions for ground or surface waters that are current or potential drinking water sources. For MCLGs set at zero, the corresponding Maximum Contaminant Level (MCL) is to be attained when determined to be relevant and appropriate.
- An Alternative Concentration Limit (ACL) can be established pursuant to CERCLA Section 121.
- Water quality standards established under the Clean Water Act Sections 303 and 304 are to be attained for releases to surface waters to be protective of aquatic life where determined to be relevant and appropriate.
- Fauna, flora, and aquatic habitats are to be considered during the establishment of the remediation goals. Environmental evaluations are to be conducted to assess threats to the environment, especially sensitive and critical habitats protected under the Endangered Species Act.

To the extent possible, chemical-specific ARARs are used to determine remediation goals. However, ARARs may not adequately consider the site-specific contamination or the cumulative effects associated with multiple contaminants and/or pathways. Therefore, chemical-specific ARARs are not always the sole determinant of protectiveness and are supplemented with risk assessments and consideration of other non-promulgated health-based criteria. The risk assessment process includes the evaluation of site-specific factors such as potential for exposure (e.g., future land use), the hazardous substances present, and the presence of sensitive populations and habitats. These factors will be considered during the development of the OU-specific BRA.

DOE proposes to develop Risk-Based Programmatic Preliminary Remediation Goals (PPRGs) which will establish initial sitewide clean up targets for each environmental medium.

The risk-based PPRGs incorporate BRA methodologies accepted on a sitewide basis. This report presents the purpose for risk-based PPRGs and methods used to calculate them. Section 2 provides information regarding the intended current and potential future uses of the risk-based PPRGs. Section 3.0 describes the exposure pathways and methodology used to calculate the risk-based PPRGs. Section 4.0 provides references for the toxicological information used for each specific contaminant. Section 5.0 gives a comprehensive list of risk-based PPRGs that are proposed to be used to develop and screen remedial technologies and alternatives.

## **2.0 PURPOSE OF RISK-BASED PROGRAMMATIC PRELIMINARY REMEDIATION GOALS**

As stated in Section 1.0, the intended purpose for calculating risk-based PPRGs is to establish sitewide clean up targets for environmental contaminants. The calculation of risk-based PPRGs is possible through the standardization of exposure pathways and risk assessment methodologies. The benefits associated with developing risk-based PPRGs include:

- Support the CMS/FS process by allowing the development of remedial technologies and alternatives to proceed without an OU-specific BRA;
- Support the Contaminant of Concern (COC) selection process within the BRA by providing "Risk-Based Concentrations";
- Support the Colorado Department of Health (CDH) conservative screen within the BRA; and
- Support the evaluation of sites where accelerated cleanup actions may be warranted.

In order to assure consistency with current risk assessment methodologies, Exposure Scenario Technical Memoranda were evaluated for use in the risk-based PPRG selection.

Although there is a certain level of risk associated with developing remedial technologies and alternatives prior to fully characterizing the risks associated with the OU contamination, the programmatic approach is consistent with the NCP. Specifically, 40 CFR 300.430(e)(2)(i) states that, "[I]nitially, preliminary remediation goals are developed based on readily available information, such as chemical-specific ARARs or other reliable information. Preliminary remediation goals should be modified, as necessary, as more information becomes available during the Remedial Investigation/Feasibility Study (RI/FS). Final remediation goals will be determined when the remedy is selected."

The "off-the-shelf" risk-based PPRGs will form the initial basis for identifying, screening, and evaluating potential remedial technologies and alternatives. However, the risk-based PPRGs are not intended to be the final justification for selecting a particular remedial alternative. Should the final BRA indicate that the risk-based PPRGs are not representative of

the actual risk posed by the contamination at the OU, the required changes will be incorporated as early as possible during the Development and Screening of Alternatives or Detailed Analysis of Alternatives.

The extensive amount of data at each OU warranted a process that would reduce the number of chemicals needing assessment in the BRA. USEPA, CDH, and DOE therefore approved a process by which COCs could be delineated at a site. One part of this process evaluates low detection frequency chemicals with respect to a Risk-Based Concentration (RBC) value. The value to be used for the RBC will be taken from the risk-based PPRG list using a residential scenario.

Data aggregation within an OU has been discussed between USEPA, CDH, and DOE, and an agreement has been reached on how this data aggregation is to be performed. To meet CDH requirements for data aggregation, the whole OU area is divided into sub-areas called "sources." Source area delineation is based on the environmental media data from the OU. After source areas are delineated, a risk-based screening process is performed for each source area. This screening process will use the residential exposure scenario values within the risk-based PPRG list.

As required by Section IX.A.1 of the IAG Statement of Work, DOE is to develop Corrective/Remedial Action objectives for each OU and document these objectives in OU-specific Technical Memoranda for submission to USEPA and/or the State for review. The objectives are to specify the contaminants and media of interest, exposure pathways and receptors, and USEPA and State accepted levels or ranges for each exposure route. The risk-based PPRGs will be used in conjunction with chemical-specific ARARs to establish acceptable PRGs for each OU. These acceptable levels or ranges (e.g., OU-specific PRGs) will be documented in the form of a Technical Memorandum.

It is projected that a risk-based evaluation will be needed to screen OUs for potential early actions. This screening evaluation will need to employ risk-based cleanup targets so that areas can be ranked with respect to human health risks. Also, high risk sites will need to be assessed with respect to the amount of cleanup required. It is projected that the risk-based PPRGs will be utilized for both of these exercises within an accelerated clean-up framework. Based on the CDH conservative screen, accelerated actions may be implemented at sites where the cumulative risk ratio is greater than 100.

### 3.0 EXPOSURE PATHWAYS

In order to standardize the risk-based PPRGs across all of the OUs, programmatic exposure pathways and receptors were established. Table 1 identifies the receptors and exposure pathways selected for each environmental media. A sand and gravel mining scenario is being examined for the possible incorporation into the risk-based PPRG document. If it is determined that this exposure scenario is required, the risk-based PPRG document will be revised accordingly. In addition, dermal exposure will be considered during the CDH conservative

**TABLE 1**  
**PROGRAMMATIC ENVIRONMENTAL MEDIA AND EXPOSURE PATHWAYS**

Environmental Media Exposure Scenario	Residential	Commercial/Industrial	Ecological Researcher
Surface Soil	Direct Ingestion of Soils <sup>a/</sup> Inhalation of Particulates <sup>b/</sup> External Radiation Exposure <sup>c/</sup>	<u>Office Worker Scenario</u> Direct Ingestion of Soils <sup>a/</sup> Inhalation of Particulates <sup>b/</sup> External Radiation Exposure <sup>c/</sup>	Direct Ingestion of Soils <sup>a/</sup> Inhalation of Particulates <sup>b/</sup> External Radiation Exposure <sup>c/</sup>
Subsurface Soil	Not Applicable	<u>Construction Worker Scenario</u> Direct Ingestion of Soils <sup>a/</sup> Inhalation of Particulates <sup>b/</sup> External Radiation Exposure <sup>c/</sup> Inhalation of Volatiles	Not Applicable
Ground Water	Direct Ingestion of Ground Water <sup>a/</sup> Inhalation During Domestic Use <sup>d/</sup>	Not Applicable	Not Applicable
Surface Water	Direct Ingestion While Swimming <sup>e/</sup>	Not Applicable	Direct Ingestion While Wading <sup>e/</sup>

**NOTES:**

- <sup>a/</sup> Includes assessment of organics and inorganics.
- <sup>b/</sup> Includes assessment of non-volatile organics and inorganics.
- <sup>c/</sup> Includes assessment of radionuclides.
- <sup>d/</sup> Includes assessment of volatile organics.
- <sup>e/</sup> Includes assessment of organics and tritium.

screen in accordance with DOE/USEPA/CDH agreements. Should the results of the CDH conservative screen indicate that the cumulative risk ratio is less than one, dermal exposure will be assessed per USEPA dermal exposure assessment guidance (USEPA, 1992).

Standard assumptions given in Risk Assessment Guidance for Superfund (RAGS), Part B (USEPA, 1991) were used in developing risk-based PPRG equations where available. For situations not addressed by RAGS, Part B, standard assumptions given in RAGS, Part A (USEPA, 1989) were used. In addition, site-specific information from Exposure Scenario Technical Memoranda for OUs 1 through 7 was used where appropriate to supplement assumptions given in USEPA guidance. Best professional judgement was applied when default values differed from site-specific information.

In addition to USEPA and site-specific information, CDH guidance (*Interim Final Policy and Guidance on Risk Assessments for Corrective Action at RCRA Facilities*) was consulted for exposure pathways and parameters. While this guidance has not been finalized, it was reviewed and CDH was consulted on its use during development of the risk-based PPRG equations.

Due to the many programs that these risk-based PPRGs will support, elements from USEPA and CDH guidance, as well as site-specific information, were used to develop the risk-based PPRGs. This compromise approach will assure that all objectives of the document are met while maintaining the health protectiveness of the risk-based PPRGs.

#### 4.0 METHODOLOGY, EQUATIONS, AND ASSUMPTIONS

This section presents the methodology, equations, and assumptions that were used to calculate the risk-based PPRGs. In general, the following USEPA guidance documents were used as the basis to derive the risk-based equations and exposure default values to calculate the risk-based PPRGs.

- *Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals*, (USEPA 1991);
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*, (USEPA 1989);
- *Changes to Equations in the Part B Guidance*, (Dinan 1992);
- *Revisions to Chapter 4: Risk-based PRGs for Radioactive Contaminants*, (USEPA 1993b); and
- *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, OSWER Directive 9285.6-03*, (USEPA, 1991b).

To ensure that all of the contaminants that may be encountered at the RFP are addressed, risk-based PPRGs were developed for all Target Analyte List (TAL) metals, Target Compound List (TCL) organics and 12 radionuclides for each receptor (i.e., resident, office worker, construction worker, and ecological researcher) and environmental media (i.e., surface soil, subsurface soil, ground water, and surface water) combination identified on Table 1. Separate risk-based equations were developed to account for the carcinogenic, noncarcinogenic, and/or radiological effects of the contaminant. Risk-based PPRGs for carcinogens (including radionuclides) were calculated by setting the carcinogenic target risk level at  $10^{-6}$ . A target risk level of  $10^{-6}$  means an individual has a one-in-one-million probability of developing cancer over a lifetime as a result of exposure to a specific contaminant. This risk is in addition to the probability of an individual developing cancer from other factors such as those associated with heredity or lifestyle. Similarly, risk-based PPRGs for toxicants (non-carcinogens) were calculated by setting the hazard index equal to 1 for each contaminant. A hazard index is the ratio between the contaminant concentration and a reference dose. The reference dose represents the exposure level to the contaminant below which adverse effects are not expected. For some of the contaminants both carcinogenic and noncarcinogenic toxicity information was available. For these contaminants, both a carcinogenic and noncarcinogenic risk-based concentration were calculated and the more restrictive value was used as the risk-based PPRG. The risk-based equations for radiological effects were used to calculate the risk-based PPRGs for the 12 radionuclides.

The risk-based PPRG equations include all of the exposure pathways (e.g., Direct Ingestion of Soils) listed in Table 1 for each exposure scenario/environmental media combination; separate risk-based PPRGs were not be calculated for each exposure pathway. When available, USEPA-specified default values were used to calculate the risk-based PPRGs. In the absence of USEPA guidance on specific parameters, site-specific default values were established based on previous DOE reports on specific operable units.

#### 4.1 Surface Soils

Exposure pathways, equations, assumptions, and default values used to calculate the surface soil risk-based PPRGs for each receptor scenario are presented in this section. The receptors considered include residential use, office worker, and ecological researcher. The risk-based equations for all receptors included the following exposure pathways:

- Direct ingestion of soils contaminated with organic and inorganic (including radionuclides) contaminants;
- Inhalation of non-volatile organic and inorganic (including radionuclides) particulates; and
- External radiation exposure due to radionuclide contaminants.

### **4.1.1 Residential Exposure**

For the residential exposure to surface soil, a combined adult and child exposure was assessed for the soil ingestion pathway. All other pathways were based on an adult exposure only.

The equations and assumptions used to derive risk-based PPRGs for surface soils with carcinogenic COCs are shown on Table 2, and the corresponding equation for COCs with noncarcinogenic effects is shown on Table 3. Table 4 shows the equation used to calculate risk-based PPRGs for radionuclides. All default values were based on USEPA guidance.

### **4.1.2 Commercial/Industrial Exposure**

For the commercial/industrial exposure to surface soils, an office worker receptor was assessed. The equations and assumptions used to derive the risk-based PPRGs for surface soils are shown on Table 5 for COCs with carcinogenic effects, on Table 6 for COCs with noncarcinogenic effects, and on Table 7 for radionuclides. All default values were based on USEPA guidance.

### **4.1.3 Ecological Researcher Exposure**

The risk-based PPRG equations and assumptions for exposure of an ecological researcher to surface soils are shown on Tables 8, 9, and 10 for potential carcinogens, noncarcinogens, and radionuclides, respectively. Because the ecological researcher is a site-specific receptor, site-specific exposure assumptions were developed. Specifically, the exposure frequency and duration were based on site-specific information. Other exposure assumptions were based on USEPA guidance pertaining to a commercial/industrial land use scenario.

## **4.2 Subsurface Soils**

This section presents the exposure pathways, equations, assumptions, and default values used to calculate the subsurface soil risk-based PPRGs. Only a construction worker scenario was considered for this environmental media and the risk-based PPRGs were based on the following exposure pathways:

- Direct ingestion of soils contaminated with organic and inorganic (including radionuclides) contaminants;
- Inhalation of non-volatile organic and inorganic (including radionuclides) particulates;
- External radiation exposure due to radionuclide contaminants; and
- Inhalation of volatiles.

TABLE 2  
SURFACE SOIL - RESIDENTIAL USE  
CARCINOGENIC EFFECTS

$$PPRG_1 = \frac{TR \times AT \times 365 \text{ days/year}}{EF \times \left[ (SF_i \times IR_a \times ED \times \frac{1}{BW} \times \frac{1}{PEF}) + (SF_o \times 10^{-6} \text{ kg/mg} \times IF) \right]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>1</sub>	Risk-based PPRG for surface soil based on residential use (mg/kg)	-
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
AT	averaging time (years)	70 years
EF	exposure frequency (days/year)	350 days/year
SF <sub>i</sub>	inhalation cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
IR <sub>a</sub>	daily inhalation rate (m <sup>3</sup> /day)	20 m <sup>3</sup> /day
ED	exposure duration (years)	30 years
BW	adult body weight (kg)	70 kg
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
SF <sub>o</sub>	oral cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
IF	age-adjusted soil ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day

Source: USEPA, 1991.

Note: Inhalation of particulates does not apply to volatile organics (i.e., Henry's Law Constant greater than 1x10<sup>5</sup> atm-m<sup>3</sup>/mole and a molecular weight less than 200 g/mole).

TABLE 3  
 SURFACE SOIL - RESIDENTIAL USE  
 NONCARCINOGENIC EFFECTS

$$PPRG_2 = \frac{THI \times AT \times 365 \text{ days/year}}{EF \times \left[ (ED \times IRa \times \frac{1}{RfDi} \times \frac{1}{BW} \times \frac{1}{PEF}) + (\frac{1}{RfDo} \times 10^{-6} \text{ kg/mg} \times IF) \right]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>2</sub>	Risk-based PPRG for surface soil based on residential use (mg/kg)	-
THI	target hazard index (unitless)	1
AT	averaging time (years)	30 years
EF	exposure frequency (days/year)	350 days/year
ED	exposure duration (years)	30 years
IRa	daily inhalation rate (m <sup>3</sup> /day)	20 m <sup>3</sup> /day
RfDi	inhalation chronic reference dose (mg/kg-day)	COC-Specific
BW	adult body weight (kg)	70 kg
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
RfDo	oral chronic reference dose (mg/kg-day)	COC-Specific
IF	age-adjusted soil ingestion rate (mg-yr/kg-day)	114 mg-yr/kg-day

Source: USEPA, 1991.

Note: Inhalation of particulates does not apply to volatile organics (i.e., Henry's Law Constant greater than 1x10<sup>-5</sup> atm-m<sup>3</sup>/mole and a molecular weight less than 200 g/mole).

TABLE 4  
 SURFACE SOIL - RESIDENTIAL USE  
 RADIOLOGICAL EFFECTS

$$PPRG_3 = \frac{TR}{(EF \times IRa \times ED \times SFi \times 10^3 \text{ g/kg} \times \frac{1}{PEF}) + (EF \times SFO \times 10^{-3} \text{ g/mg} \times IF) + (SFe \times ED \times (1 - Se) \times Te)}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>3</sub>	Risk-based PPRG for surface soil based on residential use (pCi/g)	-
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
EF	exposure frequency (days/year)	350 days/year
IRa	daily indoor inhalation rate (m <sup>3</sup> /day)	20 m <sup>3</sup> /day
ED	exposure duration (years)	30 years
SFi	inhalation cancer slope factor (risk/pCi)	COC-Specific
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
SFO	oral cancer slope factor (risk/pCi)	COC-Specific
IF	age-adjusted soil ingestion factor (mg-yr/day)	3600 mg-yr/day
SFe	external exposure slope factor (risk/yr per pCi/g)	COC-Specific
Se	gamma shielding factor (unitless)	0.2
Te	gamma exposure factor (unitless)	1

Source: USEPA, 1991; USEPA, 1993b.

**TABLE 5**  
**SURFACE SOIL - OFFICE WORKER**  
**CARCINOGENIC EFFECTS**

$$PPRG_4 = \frac{TR \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times \left[ (SFi \times IRa \times \frac{1}{PEF}) + (SFo \times 10^{-6} \text{ kg/mg} \times IRs) \right]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>4</sub>	Risk-based PPRG for surface soil based on office worker use (mg/kg)	-
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	70 years
EF	exposure frequency (days/year)	250 days/year
ED	exposure duration (years)	25 years
SFi	inhalation cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
IRa	workday inhalation rate (m <sup>3</sup> /day)	6.64 m <sup>3</sup> /day <sup>a/</sup>
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
SFo	oral cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
IRs	workday ingestion rate (mg/day)	50 mg/day

Source: USEPA, 1989; USEPA, 1991.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

Note: Inhalation of particulates does not apply to volatile organics (i.e., Henry's Law Constant greater than 1x10<sup>-5</sup> atm-m<sup>3</sup>/mole and a molecular weight less than 200 g/mole).

**TABLE 6**  
**SURFACE SOIL - OFFICE WORKER**  
**NONCARCINOGENIC EFFECTS**

$$PPRG_5 = \frac{THI \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times \left[ (IRa \times \frac{1}{RfDi} \times \frac{1}{PEF}) + (\frac{1}{RfDo} \times 10^{-6} \text{ kg/mg} \times IRs) \right]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>5</sub>	Risk-based PPRG for surface soil based on office worker use (mg/kg)	-
THI	target hazard index (unitless)	1
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	25 years
EF	exposure frequency (days/year)	250 days/year
ED	exposure duration (years)	25 years
IRa	workday inhalation rate (m <sup>3</sup> /day)	6.64 m <sup>3</sup> /day <sup>a/</sup>
RfDi	inhalation chronic reference dose (mg/kg-day)	COC-Specific
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
RfDo	oral chronic reference dose (mg/kg-day)	COC-Specific
IRs	workday ingestion rate (mg/day)	50 mg/day

Source: USEPA, 1989; USEPA, 1991.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

Note: Inhalation of particulates does not apply to volatile organics (i.e., Henry's Law Constant greater than 1x10<sup>-5</sup> atm-m<sup>3</sup>/mole and molecular weight less than 200 g/mole.)

TABLE 7  
 SURFACE SOIL - OFFICE WORKER  
 RADIOLOGICAL EFFECTS

$$PPRG_6 = \frac{ED \times \left[ (EF \times IRa \times SFi \times 10^3 \text{ g/kg} \times \frac{1}{PEF}) + (EF \times SFo \times 10^{-3} \text{ g/mg} \times IRs) + (SFe \times (1 - Se) \times Te) \right]}{TR}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>6</sub>	Risk-based PPRG for surface soil based on office worker use (pCi/g)	-
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
ED	exposure duration (years)	25 years
EF	exposure frequency (days/year)	250 days/year
IRa	workday inhalation rate (m <sup>3</sup> /day)	6.64 m <sup>3</sup> /day <sup>a/</sup>
SFi	inhalation cancer slope factor (risk/pCi)	COC-Specific
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
SFo	oral cancer slope factor (risk/pCi)	COC-Specific
IRs	workday ingestion rate (mg/day)	50 mg/day
SFe	external exposure slope factor (risk/yr per pCi/g)	COC-Specific
Se	gamma shielding factor (unitless)	0.2
Te	gamma exposure factor (unitless)	0.3

Source: USEPA, 1989; USEPA, 1991.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

**TABLE 8**  
**SURFACE SOIL - ECOLOGICAL RESEARCHER**  
**CARCINOGENIC EFFECTS**

$$PPRG_7 = \frac{TR \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times \left[ (SFi \times IRa \times \frac{1}{PEF}) + (SFo \times 10^{-6} \text{ kg/mg} \times IRs) \right]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>7</sub>	Risk-based PPRG for surface soil based on ecological researcher use (mg/kg)	10 <sup>-6</sup>
TR	target excess lifetime cancer risk (unitless)	70 kg
BW	adult body weight (kg)	70 years
AT	averaging time (years)	65 days/year <sup>b/</sup>
EF	exposure frequency (days/year)	2.5 years <sup>b/</sup>
ED	exposure duration (years)	COC-Specific
SFi	inhalation cancer slope factor (mg/kg-day) <sup>-1</sup>	6.64 m <sup>3</sup> /day <sup>a/</sup>
IRa	workday inhalation rate (m <sup>3</sup> /day)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
PEF	particulate emission factor (m <sup>3</sup> /kg)	COC-Specific
SFo	oral cancer slope factor (mg/kg-day) <sup>-1</sup>	50 mg/day
IRs	workday ingestion rate (mg/day)	

Source: USEPA, 1991; DOE, 1993b, DOE, 1993c, DOE, 1993d.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

<sup>b/</sup> Site-specific exposure factors for Rocky Flats Plant.

Note: Inhalation of particulates does not apply to volatile organics (i.e., Henry's Law Constant greater than 1x10<sup>-5</sup> atm-m<sup>3</sup>/mole and a molecular weight less than 200 g/mole).

**TABLE 9**  
**SURFACE SOIL - ECOLOGICAL RESEARCHER**  
**NONCARCINOGENIC EFFECTS**

$$PPRG_8 = \frac{THI \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times \left[ (IRa \times \frac{1}{RfDi} \times \frac{1}{PEF}) + (\frac{1}{RfDo} \times 10^{-6} \text{ kg/mg} \times IRs) \right]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>8</sub>	Risk-based PPRG for surface soil based on ecological researcher use (mg/kg)	1
THI	target hazard index (unitless)	70 kg
BW	adult body weight (kg)	2.5 years
AT	averaging time (years)	65 days/year <sup>b/</sup>
EF	exposure frequency (days/year)	2.5 years <sup>b/</sup>
ED	exposure duration (years)	6.64 m <sup>3</sup> /day <sup>a/</sup>
IRa	workday inhalation rate (m <sup>3</sup> /day)	COC-Specific
RfDi	inhalation chronic reference dose (mg/kg-day)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
PEF	particulate emission factor (m <sup>3</sup> /kg)	COC-Specific
RfDo	oral chronic reference dose (mg/kg-day)	50 mg/day
IRs	workday ingestion rate (mg/day)	

Source: USEPA, 1991; DOE, 1993b; DOE, 1993c; DOE, 1993d.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

<sup>b/</sup> Site-specific exposure factor for Rocky Flats Plant.

Note: Inhalation of particulates does not apply to volatile organics (i.e., Henry's Law Constant greater than 1x10<sup>-5</sup> atm-m<sup>3</sup>/mole and a molecular weight less than 200 g/mole).

**TABLE 10**  
**SURFACE SOIL - ECOLOGICAL RESEARCHER**  
**RADIOLOGICAL EFFECTS**

$$PPRG_9 = \frac{ED \times \left[ (EF \times IRa \times SFi \times 10^3 \text{ g/kg} \times \frac{1}{PEF}) + (EF \times SFo \times 10^{-3} \text{ g/mg} \times IRs) + (SFe \times (1 - Se) \times Te) \right]}{TR}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>9</sub>	Risk-based PPRG for surface soil based on ecological researcher use (pCi/g)	10 <sup>-6</sup>
TR	target excess lifetime cancer risk (unitless)	2.5 years <sup>b/</sup>
ED	exposure duration (years)	65 days/year <sup>b/</sup>
EF	exposure frequency (days/year)	6.64 m <sup>3</sup> /day <sup>a/</sup>
IRa	workday inhalation rate (m <sup>3</sup> /day)	COC-Specific
SFi	inhalation cancer slope factor (risk/pCi)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
PEF	particulate emission factor (m <sup>3</sup> /kg)	COC-Specific
SFo	oral cancer slope factor (risk/pCi)	50 mg/day
IRs	workday ingestion rate (mg/day)	COC-Specific
SFe	external exposure slope factor (risk/yr per pCi/g)	0.2
Se	gamma shielding factor (unitless)	0.3
Te	gamma exposure factor (unitless)	

Source: USEPA, 1991; USEPA, 1993b; DOE, 1993b; DOE, 1993c; DOE, 1993d.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

<sup>b/</sup> Site-specific exposure factor for Rocky Flats Plant.

#### **4.2.1 Residential Exposure**

A scenario involving residential exposure to subsurface soils was not considered to be credible and was therefore not included in the calculation of risk-based PPRGs.

#### **4.2.2 Commercial/Industrial Exposure**

The risk-based PPRG equations and assumptions are shown on Tables 11, 12, and 13 for potential carcinogens, noncarcinogens, and radionuclides, respectively. USEPA guidance does not specify exposure assumptions specific to a construction worker receptor. Therefore, site-specific information was used to develop assumptions for exposure frequency, exposure duration, and ingestion rate. All other exposure assumptions were based on USEPA guidance for a commercial/industrial land use scenario.

For the pathway involving inhalation of volatiles, a volatilization factor was calculated according to USEPA guidance as shown in Table 14. The volatilization model is applicable only if the soil concentration is at or below soil saturation. Thus, for those compounds for which the risk-based PPRG exceeds the soil saturation limit, the risk-based PPRG is set at the soil saturation limit. The soil saturation was calculated as shown on Table 15.

#### **4.2.3 Ecological Researcher Exposure**

The likelihood of having an ecological researcher exposed to subsurface soils was not considered to be credible and was therefore not included in the calculation of risk-based PPRGs.

### **4.3 Ground Water**

This section presents the exposure pathways, equations, assumptions, and default values used to calculate the ground water risk-based PPRGs. Residential use of the ground water was the only receptor considered. The risk-based equations included the following exposure pathways:

- Direct ingestion of ground water contaminated with organic and inorganic (including radionuclides) contaminants; and
- Inhalation of volatile organics during domestic use.

#### **4.3.1 Residential Exposure**

The equations and assumptions used to derive risk-based PPRGs for residential use of ground water are shown on Table 16 for carcinogens, Table 17 for noncarcinogens, and Table 18 for radionuclides. All default exposure assumptions were based on USEPA guidance.

**TABLE 11**  
**SUBSURFACE SOIL - CONSTRUCTION WORKER**  
**CARCINOGENIC EFFECTS**

$$PPRG_{10} = \frac{TR \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times \left[ (SFi \times IRa \times \left( \frac{1}{PEF} + \frac{1}{VF} \right)) + (SFo \times 10^{-6} \text{ kg/mg} \times IRs) \right]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>10</sub>	Risk-based PPRG for subsurface soil based on construction worker use (mg/kg)	
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	70 years
EF	exposure frequency (days/year)	30 days/year <sup>b/</sup>
ED	exposure duration (years)	1 year <sup>b/</sup>
SFi	inhalation cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
IRa	workday inhalation rate (m <sup>3</sup> /day)	6.64 m <sup>3</sup> /day <sup>a/</sup>
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
VF	soil-to-air volatilization factor (m <sup>3</sup> /kg)	COC-Specific (See Table 14)
SFo	oral cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
IRs	workday ingestion rate (mg/day)	50 mg/day <sup>b/</sup>

Source: USEPA, 1991; DOE, 1993a; DOE, 1993b; DOE, 1993c; DOE, 1993d.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

<sup>b/</sup> Site-specific exposure factor for Rocky Flats Plant.

**TABLE 12**  
**SUBSURFACE SOIL - CONSTRUCTION WORKER**  
**NONCARCINOGENIC EFFECTS**

$$PPRG_{11} = \frac{THI \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times \left[ \frac{1}{RfDi} \times \left( \frac{1}{PEF} + \frac{1}{VF} \right) \right] + \left( \frac{1}{RfDo} \times 10^{-6} \text{ kg/mg} \times IRs \right)}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>11</sub>	Risk-based PPRG for subsurface soil based on construction worker use (mg/kg)	
THI	target hazard index (unitless)	1
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	1 year
EF	exposure frequency (days/year)	30 days/year <sup>b/</sup>
ED	exposure duration (years)	1 year <sup>b/</sup>
IRa	workday inhalation rate (m <sup>3</sup> /day)	6.64 m <sup>3</sup> /day <sup>a/</sup>
RfDi	inhalation chronic reference dose (mg/kg-day)	COC-Specific
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
VF	soil-to-air volatilization factor (m <sup>3</sup> /kg)	COC-Specific (See Table 14)
RfDo	oral chronic reference dose (mg/kg-day)	COC-Specific
IRs	workday ingestion rate (mg/day)	50 mg/day <sup>b/</sup>

Source: USEPA, 1991; DOE, 1993a; DOE, 1993b; DOE, 1993c; DOE, 1993d.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

<sup>b/</sup> Site-specific exposure factor for Rocky Flats Plant.

TABLE 13  
 SUBSURFACE SOIL - CONSTRUCTION WORKER  
 RADIOLOGICAL EFFECTS

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
$PPRG_{12} =$	$ED \times \left[ (EF \times IRa \times SFi \times 10^3 \text{ g/kg} \times \frac{1}{PEF}) + (EF \times SFo \times 10^{-3} \text{ g/mg} \times IRs) + (SFe \times (1 - Se) \times Te) \right]$	
$PPRG_{12}$	Risk-based PPRG for subsurface soil based on construction worker use (pCi/g)	
TR	target excess lifetime cancer risk (unitless)	$10^{-6}$
ED	exposure duration (years)	1 year <sup>b/</sup>
EF	exposure frequency (days/year)	30 days/year <sup>b/</sup>
IRa	workday inhalation rate (m <sup>3</sup> /day)	6.64 m <sup>3</sup> /day <sup>a/</sup>
SFi	inhalation cancer slope factor (risk/pCi)	COC-Specific
PEF	particulate emission factor (m <sup>3</sup> /kg)	4.63 x 10 <sup>9</sup> m <sup>3</sup> /kg
SFo	oral cancer slope factor (risk/pCi)	COC-Specific
IRs	workday ingestion rate (mg/day)	50 mg/day <sup>b/</sup>
SFe	external exposure slope factor (risk/yr per pCi/g)	COC-Specific
Se	gamma shielding factor (unitless)	0.2
Te	gamma exposure factor (unitless)	0.3

where:

Source: USEPA, 1991; DOE, 1993a; DOE, 1993b; DOE, 1993c; DOE, 1993d.

<sup>a/</sup> Based on a total inhalation rate of 20 m<sup>3</sup>/day adjusted for an 8-hour workday.

<sup>b/</sup> Site-specific exposure factor for Rocky Flats Plant.

**TABLE 14**  
**SUBSURFACE SOIL - CONSTRUCTION WORKER**  
**VOLATILIZATION FACTOR**

$$VF = \frac{(LS \times V \times DH)}{A} \times (3.14 \times \alpha \times T)^{1/2}$$

$$2 \times D_{ei} \times P_a \times K_{as}$$

where,

$$\alpha = \frac{D_{ei} \times P_a}{P_a + \frac{(\rho_s)(1 - P_a)}{K_{as}}}$$

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
VF	volatilization factor (m <sup>3</sup> /kg)	--
LS	length of side area (m)	45
V	wind speed in mixing zone (m/s)	2
DH	diffusion height (m)	2
A	area of contamination (cm <sup>2</sup> )	20,250,000
D <sub>ei</sub>	effective diffusivity (cm <sup>2</sup> /s)	D <sub>i</sub> x (P <sub>a</sub> <sup>3.33</sup> /P <sub>t</sub> <sup>2</sup> )
P <sub>a</sub>	air-filled soil porosity (unitless)	P <sub>t</sub> - Θβ
P <sub>t</sub>	total soil porosity (unitless)	1-(β/ρ <sub>s</sub> )
Θ	soil moisture content (cm <sup>3</sup> /water/g-soil)	10% or 0.1
β	soil bulk density (g/cm <sup>3</sup> )	1.5
ρ <sub>s</sub>	true soil density or particle density (g/cm <sup>3</sup> )	2.65
K <sub>as</sub>	soil-air partition coefficient (g-soil/cm <sup>3</sup> -air)	(H/K <sub>d</sub> ) x 41, (41 is a conversion factor)
T	exposure interval (s)	7.9 x 10 <sup>8</sup>
D <sub>i</sub>	diffusivity in air (cm <sup>2</sup> /s)	COC-specific
H	Henry's Law constant (atm-m <sup>3</sup> /mole)	COC-specific
K <sub>d</sub>	soil-water partition coefficient (cm <sup>3</sup> /g)	K <sub>oc</sub> x OC
K <sub>oc</sub>	organic carbon partition coefficient (cm <sup>3</sup> )	COC-specific
OC	organic carbon content of soil (fraction)	2% or 0.02

Source: Dinan, 1992.

**TABLE 15**  
**SUBSURFACE SOIL - CONSTRUCTION WORKER**  
**VOLATILIZATION FACTOR - SATURATED CONDITIONS**

$$C_{sat} = \frac{(K_d \times C_w \times \beta) + (C_w \times P_w) + (C_w \times H^1 \times P_a)}{\beta}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
$C_{sat}$	soil saturation concentration (mg/kg)	--
$K_d$	soil-water partition coefficient (L/kg)	$K_{oc} \times OC$
$K_{oc}$	organic carbon partition coefficient (L/kg)	2% or 0.02
OC	organic carbon content of soil fraction	COC-specific
$C_w$	upper-limit of free moisture in soil (mg/L water)	$S \times \Theta_m$
$\Theta_m$	soil moisture content (kg-water/kg-soil)	10% or 0.1
S	solubility in water (mg/L water)	COC-specific
$\beta$	soil bulk density (kg/L)	1.5
$P_w$	water filled soil porosity (unitless)	$P_t - P_a$
$P_a$	air-filled soil porosity (unitless)	$P_t - \Theta\beta$
$\Theta$	soil moisture content (L water/kg soil)	10% or 0.1
$P_t$	total soil porosity (unitless)	$1 - (\beta/\rho_s)$
$\rho_s$	true soil density or particle density (kg/L)	2.65
$H^1$	Henry's Law constant (unitless)	$H \times 41$ , (41 is a conversion factor)
H	Henry's Law constant (atm-m <sup>3</sup> /mole)	COC-specific

Source: Dinan, 1992.

TABLE 16  
GROUND WATER - RESIDENTIAL USE  
CARCINOGENIC EFFECTS

$$PPRG_{13} = \frac{TR \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times [(SFi \times IRa \times K) + (SFO \times IRw)]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>13</sub>	Risk-based PPRG for ground water based on residential use (mg/L)	-
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	70 years
EF	exposure frequency (days/year)	350 days/year
ED	exposure duration (years)	30 years
SFi	inhalation cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
IRa	daily indoor inhalation rate (m <sup>3</sup> /day)	15 m <sup>3</sup> /day
K	volatilization factor (L/m <sup>3</sup> )	0.0005 x 1000 L/m <sup>3</sup>
SFO	oral cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
IRw	daily water ingestion rate (L/day)	2 L/day

Source: USEPA, 1991.

Note: Inhalation component applies only to volatile organics (i.e., Henry's Law Constant greater than 1x10<sup>-5</sup> atm-m<sup>3</sup>/mole and molecular weight less than 200 g/mole.)

TABLE 17  
GROUND WATER - RESIDENTIAL USE  
NONCARCINOGENIC EFFECTS

$$PPRG_{14} = \frac{THI \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times \left[ (IRa \times \frac{1}{RfDi} \times K) + (\frac{1}{RfDo} \times IRw) \right]}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>14</sub>	Risk-based PPRG for ground water based on residential use (mg/L)	-
THI	target hazard index (unitless)	1
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	30 years
EF	exposure frequency (days/year)	350 days/year
ED	exposure duration (years)	30 years
IRa	daily indoor inhalation rate (m <sup>3</sup> /day)	15 m <sup>3</sup> /day
RfDi	inhalation chronic reference dose (mg/kg-day)	COC-Specific
K	volatilization factor (L/m <sup>3</sup> )	0.0005 x 1000 L/m <sup>3</sup>
RfDo	oral chronic reference dose (mg/kg-day)	COC-Specific
IRw	daily water ingestion rate (L/day)	2 L/day

Source: USEPA, 1991.

Note: Inhalation component applies only to volatile organics (i.e., Henry's Law Constant greater than 1x10<sup>-5</sup> atm-m<sup>3</sup>/mole and molecular weight less than 200 g/mole.)

**TABLE 18**  
**GROUND WATER - RESIDENTIAL USE**  
**RADIOLOGICAL EFFECTS**

$$PPRG_{15} = \frac{TR}{EF \times ED \times (SFo \times IRw)}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>15</sub>	Risk-based PPRG for ground water based on residential use (pCi/L)	-
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
EF	exposure frequency (days/year)	350 days/year
ED	exposure duration (years)	30 years
SFo	oral cancer slope factor (risk/pCi)	COC-Specific
IRw	daily water ingestion rate (L/day)	2 L/day

Source: USEPA, 1991.

#### **4.3.2 Commercial/Industrial Exposure**

A scenario involving commercial/industrial exposure to ground water was not considered to be credible and was therefore not included in the calculation of risk-based PPRGs.

#### **4.3.3 Ecological Researcher Exposure**

A scenario involving exposure of an ecological researcher to ground water was not considered to be credible and was therefore not included in the calculation of risk-based PPRGs.

### **4.4 Surface Water**

This section presents the exposure pathways, equations, assumptions, and default values used to calculate the surface water risk-based PPRGs for each receptor scenario. The receptors considered include residential use and ecological researcher. The risk-based equations for the residential receptor were based on exposure via swimming, while the risk-based equations for the ecological researcher were based on exposure via wading. For both receptors, the exposure pathways included direct ingestion of surface water.

#### **4.4.1 Residential Exposure**

The equations and assumptions used to derive risk-based PPRGs for residential exposure to surface water while swimming are shown on Tables 19 through 21 for carcinogens, noncarcinogens, and radionuclides, respectively. All assumptions were based on USEPA guidance.

#### **4.4.2 Commercial/Industrial Exposure**

The likelihood of having a commercial/industrial exposure to surface water was not considered to be credible and was therefore not included in the calculation of risk-based PPRGs.

#### **4.4.3 Ecological Researcher Exposure**

The risk-based PPRG equations and assumptions for exposure of an ecological researcher to surface water while wading are shown on Tables 22 through 24 for carcinogens, noncarcinogens, and radionuclides, respectively. USEPA guidance does not provide default values specific to this receptor. Therefore, site-specific information was used to determine exposure frequency and duration. All other exposure assumptions were based on USEPA guidance for swimming.

**TABLE 19**  
**SURFACE WATER - RESIDENTIAL USE**  
**CARCINOGENIC EFFECTS**

$$PPRG_{16} = \frac{TR \times BW \times AT \times 365 \text{ days/year}}{CRW \times ET \times EF \times ED \times SFo}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>16</sub>	Risk-based PPRG for surface water based on residential use (mg/L)	-
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
SFo	oral cancer slope factor (mg/kg-day) <sup>1</sup>	COC-Specific
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	70 years
EF	exposure frequency (days/year)	7 days/year
ED	exposure duration (years)	30 years
CRW	contact rate (L/hour)	0.05 L/hour
ET	exposure time (hours/day)	2.6 hours/day

Source: USEPA, 1989.

TABLE 20  
 SURFACE WATER - RESIDENTIAL USE  
 NONCARCINOGENIC EFFECTS

$$PPRG_{17} = \frac{THI \times BW \times AT \times 365 \text{ days/year} \times RfDo}{CRw \times ET \times EF \times ED}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>17</sub>	Risk-based PPRG for surface water based on residential use (mg/L)	-
THI	target hazard index (unitless)	1
RfDo	oral chronic reference dose (mg/kg-day)	COC-Specific
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	30 years
EF	exposure frequency (days/year)	7 days/year
ED	exposure duration (years)	30 years
CRw	contact rate (L/hour)	0.05 L/hour
ET	exposure time (hours/day)	2.6 hours/day

Source: USEPA, 1989.

**TABLE 21**  
**SURFACE WATER - RESIDENTIAL USE**  
**RADIOLOGICAL EFFECTS**

$$PPRG_{18} = \frac{TR}{SF_0 \times EF \times ED \times CR_w \times ET}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>18</sub>	Risk-based PPRG for surface water based on residential use (pCi/L)	-
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
SF <sub>0</sub>	oral cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
EF	exposure frequency (days/year)	7 days/year
ED	exposure duration (years)	30 years
CR <sub>w</sub>	contact rate (L/hour)	0.05 L/hour
ET	exposure time (hours/day)	2.6 hours/day

Source: USEPA, 1989; USEPA, 1991.

TABLE 22  
SURFACE WATER - ECOLOGICAL RESEARCHER  
CARCINOGENIC EFFECTS

$$PPRG_{19} = \frac{TR \times BW \times AT \times 365 \text{ days/year}}{IRW \times EF \times ED \times SFo}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>19</sub>	Risk-based PPRG for surface water based on ecological researcher use (mg/L)	
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
SFo	oral cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
BW	adult body weight (kg)	70 kg
AT	averaging time (years)	70 years
EF	exposure frequency (events/year)	7 events/year <sup>a/</sup>
ED	exposure duration (years)	2.5 years <sup>a/</sup>
IRW	ingestion rate (L/event)	0.05 L/event

Source: USEPA, 1989; DOE, 1993c; DOE, 1993d.

<sup>a/</sup> Site-specific exposure factor for Rocky Flats Plant.

TABLE 23  
SURFACE WATER - ECOLOGICAL RESEARCHER  
NONCARCINOGENIC EFFECTS

$$PPRG_{20} = \frac{THI \times BW \times AT \times 365 \text{ days/year} \times RfDo}{IRw \times EF \times ED}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>20</sub>	Risk-based PPRG for surface water based on ecological researcher use (mg/L)	1
THI	target hazard index (unitless)	COC-Specific
RfDo	oral chronic reference dose (mg/kg-day)	70 kg
BW	adult body weight (kg)	2.5 years
AT	averaging time (years)	7 events/year <sup>a/</sup>
EF	exposure frequency (events/year)	2.5 years <sup>a/</sup>
ED	exposure duration (years)	0.05 L/event
IRw	ingestion rate (L/event)	

Source: USEPA, 1989; DOE, 1993c; DOE, 1993d.

<sup>a/</sup> Site-specific exposure factor for Rocky Flats Plant.

TABLE 24  
 SURFACE WATER - ECOLOGICAL RESEARCHER  
 RADIOLOGICAL EFFECTS

$$PPRG_{21} = \frac{TR}{SFo \times EF \times ED \times IRw}$$

where:

<u>Variable</u>	<u>Explanation (Units)</u>	<u>Default Value</u>
PPRG <sub>21</sub>	Risk-based PPRG for surface water based on ecological researcher use (pCi/L)	
TR	target excess lifetime cancer risk (unitless)	10 <sup>-6</sup>
SFo	oral cancer slope factor (mg/kg-day) <sup>-1</sup>	COC-Specific
EF	exposure frequency (events/year)	7 events/year <sup>a/</sup>
ED	exposure duration (years)	2.5 years <sup>a/</sup>
IRw	ingestion rate (L/event)	0.05 L/event

Source: USEPA, 1991; DOE, 1993c; DOE, 1993d.

<sup>a/</sup> Site-specific exposure factor for Rocky Flats Plant.

## 5.0 CONTAMINANT TOXICITY INFORMATION

The COC-specific toxicology values used for the calculation of the risk-based PPRGs are presented in Table 25. The toxicity information used to calculate the risk-based PPRGs included the slope factor and unit risk for evaluating carcinogenic effects and the reference dose (RfD) and the reference concentration (RfC) for evaluating noncarcinogenic effects. Toxicity values were obtained from the latest information contained on the Integrated Risk Information System (IRIS). If values were not available from IRIS, the *Health Effects Assessment Summary Tables Annual Update*, (USEPA 1993a) was consulted. Values for polycyclic aromatic hydrocarbons were calculated using USEPA guidance entitled *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (USEPA 1993c).

## 6.0 RISK-BASED PROGRAMMATIC PRELIMINARY REMEDIATION GOALS

For each potential COC, the calculated risk-based PPRG for the exposure scenario (i.e., receptor and environmental media combination identified on Table 1) are given on Table 26. Where a chemical has both carcinogenic and noncarcinogenic effects, the more stringent of the calculated risk-based levels was selected as the risk-based PPRG. The calculated risk-based PPRGs are generally pertinent to all of the OUs should the contaminant be identified as an OU-specific COC. However, OU-specific factors may disqualify some or all of the risk-based PPRGs should these factors preclude one or more of the exposure pathways which formed the basis of the risk-based equations. For example, the risk-based PPRGs for the ground water media may not be applicable at OUs where the ground water is not of sufficient quantity or quality to support domestic residential use. Also, residential use risk-based PPRGs may not be appropriate for areas where the future land use will be solely devoted to commercial and/or industrial facilities.

As stated early, the programmatic risk-based PRGs presented in Table 26 are not intended to be the final cleanup standards listed in the ROD. Other factors such as, but not limited to, background contaminant concentrations, results of the OU-specific BRA, technology limitations, detection methods, chemical-specific ARARs, cost-benefit evaluations, worker safety, and ecological effects will need to be considered when establishing the final cleanup standards. The risk-based PPRGs are to be used as a standardized set of limits to enable screening of potential remedial technologies and alternatives. As additional information is obtained through the RFI/RI and CMS/FS processes, it may be determined that the risk-based PPRGs are not representative of the actual risk posed by the contamination at the OU. If this situation occurs, the required changes will be incorporated as soon as possible during the Development and Screening of Alternatives or Detailed Analysis of Alternatives.

TABLE 25  
COC--Specific Toxicity Values\*

Target Analyte List Chemical	Oral RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Inhalation RfD (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	External Slope Factor (risk/yr per pCi/g)	Henry's Law Constant (atm-m <sup>3</sup> /mol)	Koc (ml/g)	Water Solubility (mg/L)	Diffusivity
Acenaphthene#	6.00E-02	-	-	-	-	9.20E-05 k	4600 k	3.42E+00 k	
Acenaphthylene#	-	-	-	-	-	1.48E-03 k	2500 k	3.93E+00 k	
Acetone#	1.00E-01	-	-	-	-	2.06E-05 k	2.2 k	1.00E+06 k	0.1093 l
Aldrin	3.00E-05	1.70E+01	-	1.72E+01 b	-	1.60E-05 k	96000 k	-	
Aluminum	-	-	-	-	-	-	-	-	
Anthracene#	3.00E-01	-	-	-	-	1.02E-03 k	14000 k	4.50E-02 k	
Antimony	4.00E-04	-	-	-	-	-	-	-	
Aroclor-1016	7.00E-05 c	7.70E+00 c	-	-	-	1.07E-03 k	530000 k	-	0.05571
Aroclor-1221	7.00E-05 c	7.70E+00 c	-	-	-	1.07E-03 k	530000 k	-	0.05571
Aroclor-1232	7.00E-05 c	7.70E+00 c	-	-	-	1.07E-03 k	530000 k	-	0.05571
Aroclor-1242	7.00E-05 c	7.70E+00 c	-	-	-	1.07E-03 k	530000 k	-	0.05571
Aroclor-1248	7.00E-05 c	7.70E+00 c	-	-	-	1.07E-03 k	530000 k	-	0.05571
Aroclor-1254	7.00E-05 c	7.70E+00 c	-	-	-	1.07E-03 k	530000 k	-	0.05571
Aroclor-1260	7.00E-05 c	7.70E+00 c	-	-	-	1.07E-03 k	530000 k	-	0.05571
Arsenic	3.00E-04	1.75E+00 g	-	1.51E+01	-	-	-	-	
Barium	7.00E-02	-	1.43E-04	-	-	-	-	-	
Benzene#	-	2.90E-02	-	2.91E-02 b	-	5.59E-03 k	83 k	1.75E+03 k	0.09234 l
alpha-BHC	-	6.30E+00	-	6.30E+00 h	-	5.87E-06 k	3800 k	-	
beta-BHC	-	1.80E+00	-	1.86E+00 h	-	4.47E-07 k	3800 k	-	
delta-BHC	-	-	-	-	-	2.07E-07 k	6600 k	-	
gamma-BHC (Lindane)	-	-	-	-	-	7.85E-06 k	1080 k	-	
Benzo(a)anthracene	3.00E-04	1.30E+00 b	-	-	-	1.16E-06 k	1380000 k	-	
Benzo(a)pyrene	-	7.30E-01 i	-	-	-	1.55E-06 k	5500000 k	-	
Benzo(b)fluoranthene	-	7.30E+00	-	-	-	1.19E-05 k	550000 k	-	
Benzo(g,h,i)perylene	-	-	-	-	-	5.34E-08 k	1600000 k	-	
Benzo(k)fluoranthene	-	7.30E-02 i	-	-	-	3.94E-05 k	550000 k	-	
Benzoic Acid	4.00E+00	-	-	-	-	-	-	-	
Benzyl Alcohol	3.00E-01 b	-	-	-	-	-	-	-	
Beryllium	5.00E-03	4.30E+00	-	8.40E+00 b	-	-	-	-	
bis(2-Chloroethoxy)methane#	-	-	-	-	-	1.70E-07	7	-	
bis(2-Chloroethyl)ether#	-	1.10E+00	-	-	-	1.31E-05 k	13.9 k	1.02E+04 k	
bis(2-Chloroisopropyl)ether#	4.00E-02	7.00E-02 b	-	1.16E+00 b	-	1.13E-04 k	61 k	1.70E+03 k	
bis(2-Ethylhexyl)phthalate	2.00E-02	1.40E-02	-	3.50E-02 b	-	1.00E-04	10000	-	
Bromodichloromethane#	2.00E-02	6.20E-02	-	-	-	1.60E-03	53	-	
Bromoform#	2.00E-02	7.90E-03	-	3.85E-03 b	-	6.60E-04	98	-	0.1088 l
Bromomethane#	1.40E-03	-	1.43E-03	-	-	6.24E-03	126	-	
4-Bromophenyl phenyl ether	-	-	-	-	-	-	-	-	
2-Butanone#	6.00E-01	-	2.86E-01	-	-	-	-	-	0.09485 l
Butylbenzylphthalate	2.00E-01	-	-	-	-	-	-	-	
Cadmium	5.00E-04	-	-	6.30E+00	-	-	-	-	
Calcium	-	-	-	-	-	-	-	-	
Carbon disulfide#	1.00E-01	-	2.86E-03 b	-	-	1.23E-02 k	54 k	2.94E+03 k	
Carbon tetrachloride#	7.00E-04	1.30E-01	-	5.25E-02	-	2.41E-02 k	110 k	7.57E+02 k	0.08451 l

TABLE 25  
COC--Specific Toxicity Values\*

Target Analyte List Chemical	Oral RID (mg/kg-day)	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Inhalation RID (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	External Slope Factor (risk/yr per pCi/g)	Henry's Law Constant (atm-m <sup>3</sup> /mol)	Koc (ml/g)	Water Solubility (mg/L)	Diffusivity
Cesium	-	-	-	-	-	-	-	-	-
alpha-Chlordane	6.00E-05 d	1.30E+00 d	-	1.30E+00 d	-	9.63E-06 k	140000 k	-	-
beta-Chlordane	6.00E-05 d	1.30E+00 d	-	1.30E+00 d	-	9.63E-06 k	140000 k	-	-
gamma-Chlordane	6.00E-05 d	1.30E+00 d	-	1.30E+00 d	-	9.63E-06 k	140000 k	-	-
4-Chloroaniline	4.00E-03	-	-	-	-	-	-	-	-
Chlorobenzene#	2.00E-02	-	5.71E-03 b	-	-	3.72E-03 k	330 k	4.66E+02 k	0.07627 l
Chloroethane#	-	-	2.86E+00	-	-	8.48E-03	33	-	0.11031 l
Chloroform#	1.00E-02	6.10E-03	-	8.05E-02	-	2.87E-03 k	31 k	8.20E+03 k	0.09404 l
Chloromethane#	-	1.30E-02	-	6.30E-03	-	8.82E-02	-	-	0.11827 l
4-Chloro-3-methylphenol	-	-	-	-	-	-	-	-	-
2-Chlorophthalene#	8.00E-02	-	-	-	-	1.30E-05	15	-	-
2-Chlorophenol#	5.00E-03	-	-	-	-	-	-	-	-
4-Chlorophenyl phenyl ether	-	-	-	-	-	-	-	-	-
Chromium III	1.00E+00	-	-	-	-	-	-	-	-
Chromium VI	5.00E-03	-	-	-	-	-	-	-	-
Chrysene	-	7.30E-03 i	-	4.10E+01 b	-	1.05E-06 k	200000 k	-	-
Cobalt	-	-	-	-	-	-	-	-	-
Copper	4.00E-02 b	-	-	-	-	-	-	-	-
Cyanide	2.00E-02	-	-	-	-	-	-	-	-
4,4-DDD	-	2.40E-01	-	-	-	7.96E-06 k	770000 k	-	-
4,4-DDE	-	3.40E-01	-	-	-	6.80E-05 k	440000 k	-	-
4,4-DDT	5.00E-04	3.40E-01	-	3.40E-01 h	-	5.13E-04 k	243000 k	-	-
Dibenz(a,h)anthracene	-	7.30E+00 i	-	-	-	7.33E-08 k	3300000 k	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-
Dibromochloromethane	2.00E-02	8.40E-02	-	-	-	-	-	-	-
Di-n-butylphthalate	1.00E-01	-	-	-	-	2.82E-07 k	170000 k	-	-
1,2-Dichlorobenzene#	9.00E-02	-	5.71E-02	-	-	1.93E-03 k	1700 k	1.00E+02 k	-
1,3-Dichlorobenzene#	-	-	-	-	-	3.59E-03 k	1700 k	1.23E+02 k	-
1,4-Dichlorobenzene#	-	2.40E-02 b	2.29E-01 b	-	-	2.89E-03 k	1700 k	7.90E+01 k	-
3,3-Dichlorobenzidine	-	4.50E-01	-	-	-	8.33E-07 k	1553 k	-	-
1,1-Dichloroethane#	1.00E-01 b	-	1.43E-01	-	-	4.31E-03 k	30 k	5.50E+03 k	0.09643 l
1,2-Dichloroethane#	-	9.10E-02	-	9.10E-02	-	9.78E-04 k	14 k	8.52E+03 k	0.09643 l
1,1-Dichloroethene#	9.00E-03	6.00E-01	-	1.20E+00 b	-	3.40E-02 k	65 k	2.25E+03 k	0.08386 l
1,2-Dichloroethene (total)#	9.00E-03 b	-	-	-	-	-	36	-	-
2,4-Dichlorophenol	3.00E-03	-	-	-	-	2.75E-06 k	380 k	-	-
1,2-Dichloropropane#	-	6.80E-02 b	1.14E-03	-	-	2.31E-03 k	51 k	2.70E+03 k	-
cis-1,3-Dichloropropene#	3.00E-04	1.80E-01 b,c	5.71E-03	1.30E-01 b,c	-	2.40E-03	23	-	-
trans-1,3-Dichloropropene#	3.00E-04	1.80E-01 b,c	5.71E-03	1.30E-01 b,c	-	1.80E-03	26	-	-
Dieldrin	5.00E-05	1.60E+01	-	2.91E-02 b	-	4.58E-07 k	1700 k	-	-
Diethylphthalate	8.00E-01	-	-	-	-	1.14E-06 k	142 k	-	-
2,4-Dimethylphenol#	2.00E-02	-	-	-	-	6.00E-07	425	-	-
Dimethylphthalate	1.00E+01	-	-	-	-	-	-	-	-
4,6-Dinitro-2-methylphenol#	-	-	-	-	-	4.80E-11	225	-	-

TABLE 25  
COC-Specific Toxicity Values\*

Target Analyte List Chemical	Oral RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Inhalation RfD (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	External Slope Factor (risk/yr per pCi/g)	Henry's Law Constant (atm-m <sup>3</sup> /mol)	Koc (ml/g)	Water Solubility (mg/L)	Diffusivity
2,4-Dinitrophenol	2.00E-03	-	-	-	-	6.45E-10 k	16.6 k	-	-
2,4-Dinitrotoluene	2.00E-03	-	-	-	-	5.09E-06 k	45 k	-	-
2,6-Dinitrotoluene	1.00E-03 b	-	-	-	-	3.27E-06 k	92 k	-	-
Di-n-octylphthalate	2.00E-02	-	-	-	-	-	-	-	-
Endosulfan I	5.00E-05 b,f	-	-	-	-	-	-	-	-
Endosulfan II	5.00E-05 b,f	-	-	-	-	-	-	-	-
Endosulfan sulfate	5.00E-05 b,f	-	-	-	-	-	-	-	-
Endosulfan (technical)	5.00E-05 b	-	-	-	-	-	-	-	-
Endrin ketone	-	-	-	-	-	-	-	-	-
Endrin (technical)	3.00E-04	-	-	-	-	-	-	-	-
Ethylbenzene#	1.00E-01	-	2.86E-01	-	-	6.43E-03 k	1100 k	1.52E+02 k	0.0707 l
Fluoranthene	4.00E-02	-	-	-	-	6.46E-06 k	38000 k	-	-
Fluorene#	4.00E-02	-	-	-	-	6.42E-05 k	7300 k	1.69E+00 k	-
Heptachlor	5.00E-04	4.50E+00	-	4.50E+00 b	-	8.19E-04 k	12000 k	-	-
Heptachlor epoxide	1.30E-05	9.10E+00	-	9.10E+00 b	-	4.39E-04 k	220 k	-	-
Hexachlorobenzene	8.00E-04	1.60E+00	-	1.60E+00 b	-	6.81E-04 k	3900 k	-	-
Hexachlorobutadiene	-	-	-	7.70E-02	-	4.57E+00 k	29000 k	-	-
Hexachlorocyclopentadiene	7.00E-03	-	2.00E-05	-	-	1.37E-02 k	4800 k	-	-
Hexachloroethane	1.00E-03	1.40E-02	-	1.40E-02	-	2.49E-03 k	20000 k	-	-
2-Hexanone#	-	-	-	-	-	3.39E-05	134	-	-
Indeno(1,2,3-cd)pyrene	-	7.30E-01 i	-	-	-	6.86E-08 k	1600000 k	-	-
Iron	-	-	-	-	-	-	-	-	-
Isophorone	2.00E-01	9.50E-04	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-
Lithium	-	-	-	-	-	-	-	-	-
Magnesium	-	-	-	-	-	-	-	-	-
Manganese	5.00E-03	-	1.43E-05	-	-	-	-	-	-
Mercury	3.00E-04 b	-	8.57E-05	-	-	-	-	-	-
Methoxychlor	5.00E-03	-	-	-	-	-	-	-	-
Methylene chloride#	6.00E-02	7.50E-03	8.57E-01	1.64E-03	-	-	48	-	-
2-Methylnaphthalene#	-	-	-	-	-	5.18E-04	8500	-	-
4-Methyl-2-pentanone#	5.00E-02	-	2.29E-02	-	-	9.40E-05	19	-	-
2-Methylphenol	5.00E-02	-	-	-	-	-	-	-	-
4-Methylphenol	5.00E-03 b	-	-	-	-	-	-	-	-
Molybdenum	5.00E-03	-	-	-	-	-	594	-	-
Naphthalene#	4.00E-02 b	-	-	-	-	-	-	-	-
Nickel	2.00E-02	-	-	-	-	-	-	-	-
2-Nitroaniline	-	-	-	-	-	-	-	-	-
3-Nitroaniline	-	-	-	-	-	-	-	-	-
4-Nitroaniline	-	-	-	-	-	-	-	-	-
Nitrobenzene#	5.00E-04	-	5.71E-04	-	-	2.20E-05	36	1.90E+03 k	-
2-Nitrophenol	-	-	-	-	-	-	-	-	-
4-Nitrophenol#	-	-	-	-	-	-	21	-	-

TABLE 25  
COC—Specific Toxicity Values\*

Target Analyte List Chemical	Oral RID (mg/kg-day)	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Inhalation RID (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	External Slope Factor (risk/yr per pCi/g)	Henry's Law Constant (atm-m <sup>3</sup> /mol)	Koc (ml/g)	Water Solubility (mg/L)	Diffusivity
n-Nitrosodiphenylamine#	-	4.90E-03	-	-	-	6.40E-04	1200	-	-
n-Nitrosodipropylamine	-	7.00E+00	-	-	-	6.92E-06 k	15 k	9.90E+03 k	-
Pentachlorophenol	3.00E-02	1.20E-01	-	-	-	2.75E-06 k	53000 k	-	-
Phenanthrene#	-	-	-	-	-	1.59E-04 k	14000 k	1.00E+00 k	-
Phenol	6.00E-01	-	-	-	-	4.54E-07 k	14.2 k	-	0.08924 l
Potassium	-	-	-	-	-	-	-	-	-
Pyrene	3.00E-02	-	-	-	-	5.04E-06 k	38000 k	-	-
Selenium	5.00E-03	-	-	-	-	-	-	-	-
Silver	5.00E-03	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-
Strontium	6.00E-01	-	-	-	-	-	-	-	-
Styrene#	2.00E-01	-	2.86E-01	-	-	5.20E-03	270	-	0.0746 l
1,1,2,2-Tetrachloroethane#	-	2.00E-01	-	2.00E-01 b	-	3.81E-04 k	118 k	2.90E+03 k	-
Tetrachloroethene#	1.00E-02	5.20E-02 j	-	2.03E-03	-	2.59E-02 k	364 k	-	0.07852 l
Thallium	-	-	-	-	-	-	-	-	-
Tin	6.00E-01 b	-	-	-	-	-	-	-	-
Toluene#	2.00E-01	-	1.14E-01	-	-	6.37E-03 k	300 k	5.35E+02 k	0.08301 l
Toxaphene	-	1.10E+00	-	1.10E+00 b	-	4.36E-01 k	964 k	-	-
1,2,4-Trichlorobenzene#	1.00E-02	-	2.57E-03	-	-	2.31E-03 k	9200 k	3.00E+01 k	-
1,1,1-Trichloroethane#	-	-	-	-	-	1.44E-02 k	152 k	-	-
1,1,2-Trichloroethane#	4.00E-03	5.70E-02	-	5.60E-02	-	1.17E-03 k	56 k	4.50E+03 k	-
Trichloroethene#	-	1.10E-02	-	5.95E-03	-	9.10E-03 k	126 k	1.10E+03 k	0.08606 l
2,4,5-Trichlorophenol	1.00E-01	-	-	-	-	2.18E-04 k	89 k	-	-
2,4,6-Trichlorophenol	-	1.10E-02	-	1.00E-02 b	-	3.90E-06 k	2000 k	-	-
Vanadium	7.00E-03 b	-	-	-	-	-	-	-	-
Vinylacetate	1.00E+00 b	-	5.71E-02	-	-	-	-	-	-
Vinyl chloride#	-	1.90E+00 b	-	3.00E-01 b	-	8.19E-02 k	57 k	2.67E+03 k	0.11375 l
Xylene (total)#	2.00E+00	-	-	-	-	7.04E-03 k	240 k	1.98E+02 k	0.07597 l
Zinc	3.00E-01	-	-	-	-	-	-	-	-
Nitric	1.60E+00	-	-	-	-	-	-	-	-
Nitrite	1.00E-01	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-
Sulfide	-	-	-	-	-	-	-	-	-
Ammonium	-	-	-	-	-	-	-	-	-
Bicarbonate	-	-	-	-	-	-	-	-	-
Bromide	-	-	-	-	-	-	-	-	-
Carbonate	-	-	-	-	-	-	-	-	-
Chloride	-	-	-	-	-	-	-	-	-
Cyanide	-	-	-	-	-	-	-	-	-
Fluoride	6.00E-02	-	-	-	-	-	-	-	-
Orthophosphate	-	-	-	-	-	-	-	-	-

TABLE 25  
COC-Specific Toxicity Values\*

Target Analyte List Chemical	Oral RID (mg/kg-day)	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Inhalation RID (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) <sup>-1</sup>	External Slope Factor (risk/yr per pCi/g)	Henry's Law Constant (atm-m <sup>3</sup> /mol)	Koc (ml/g)	Water Solubility (mg/L)	Diffusivity
Silica (as Si and SiO <sub>2</sub> ) Sulfate	-	-	-	-	-	-	-	-	-
Americium-241	-	2.40E-10 b*	-	3.20E-08 b*	4.90E-09 b	-	-	-	-
Cesium-137	-	2.80E-11 b*	-	1.90E-11 b*	0.00E+00 b	-	-	-	-
Plutonium-239	-	2.30E-10 b*	-	3.80E-08 b*	1.70E-11 b	-	-	-	-
Plutonium-240	-	2.30E-10 b*	-	3.80E-08 b*	2.70E-11 b	-	-	-	-
Radium-226	-	1.20E-10 b*	-	3.00E-09 b*	1.20E-08 b	-	-	-	-
Radium-228	-	1.00E-10 b*	-	6.60E-10 b*	0.00E+00 b	-	-	-	-
Strontium-89	-	3.00E-12 b*	-	2.90E-12 b*	4.70E-10 b	-	-	-	-
Strontium-90	-	3.30E-11 b*	-	5.60E-11 b*	0.00E+00 b	-	-	-	-
Tritium	-	5.40E-14 b*	-	7.80E-14 b*	0.00E+00 b	-	-	-	-
Uranium-233	-	1.60E-11 b*	-	2.70E-08 b*	4.20E-11 b	-	-	-	-
Uranium-234	-	1.60E-11 b*	-	2.60E-08 b*	3.00E-11 b	-	-	-	-
Uranium-235	-	1.60E-11 b*	-	2.50E-08 b*	2.40E-07 b	-	-	-	-
Uranium-238	-	1.60E-11 b*	-	2.40E-08 b*	2.10E-11 b	-	-	-	-

# = Chemicals listed are volatile.

\* = Values given are in units of risk/pCi.

a = All toxicity values are from IRIS, February 1994 unless otherwise noted.

b = Values given are from HEAST, 1993.

c = Values given are for PCBs.

d = Values given are for chlordane.

e = Values given are for 1,3-dichloropropene.

f = Values given are for endosulfan.

g = Value given for arsenic is calculated from an oral unit risk of 5E-5 (L/μg).

h = Values given for chemicals were calculated from HEAST.

i = Values given for PAHs were found in the EPA guidance document "Research and Development - Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons."

j = Values given for tetrachloroethene are from a U.S. EPA memo from the Office of Research and Development Environmental Criteria and Assessment Office.

k = Values given are found in the Superfund Public Health Evaluation Manual, 1986.

l = Values given are found in the Superfund Exposure Assessment Manual, 1988.

TABLE 26  
PROGRAMMATIC PRGs FOR ROCKY FLATS PLANT

Target Analyte List Chemical	Residential Groundwater (mg/L)	Residential Surface Water Swimming (mg/L)	Residential Soil (mg/kg)	Office Worker Soil (mg/kg)	Construction Worker Subsurface Soil (mg/kg)	Wading Ecological Worker (mg/L)	Soil Ecological Worker (mg/kg)
Acenaphthene#	2.19E+00	1.68E+03	1.65E+04	1.23E+05	1.02E+06	4.38E+03	1.48E+05
Acenaphthylene#	-	-	-	-	-	-	-
Acetone#	3.65E+00	2.81E+03	2.74E+04	2.04E+05	1.70E+06	7.30E+03	2.47E+05
Aldrin	5.00E-06	3.85E-03	3.77E-02	3.36E-01	7.01E+01	1.20E-01	4.07E-01
Aluminum	-	-	-	-	-	-	-
Anthracene#	1.09E+01	8.42E+03	8.23E+04	6.13E+05	5.11E+06	2.19E+04	7.41E+05
Antimony	1.46E-02	1.12E+01	1.10E+02	8.18E+02	6.81E+03	2.92E+01	9.87E+02
Aroclor-1016	1.10E-05	8.51E-03	8.32E-02	7.43E-01	1.55E+02	2.65E-01	8.98E-01
Aroclor-1221	1.10E-05	8.51E-03	8.32E-02	7.43E-01	1.55E+02	2.65E-01	8.98E-01
Aroclor-1232	1.10E-05	8.51E-03	8.32E-02	7.43E-01	1.55E+02	2.65E-01	8.98E-01
Aroclor-1242	1.10E-05	8.51E-03	8.32E-02	7.43E-01	1.55E+02	2.65E-01	8.98E-01
Aroclor-1248	1.10E-05	8.51E-03	8.32E-02	7.43E-01	1.55E+02	2.65E-01	8.98E-01
Aroclor-1254	1.10E-05	8.51E-03	8.32E-02	7.43E-01	1.55E+02	2.65E-01	8.98E-01
Aroclor-1260	1.10E-05	8.51E-03	8.32E-02	7.43E-01	1.55E+02	2.65E-01	8.98E-01
Arsenic	4.86E-05	3.74E-02	3.66E-01	3.27E+00	6.81E+02	1.17E+00	3.95E+00
Barium	2.56E+00	1.97E+03	1.92E+04	1.41E+05	1.19E+06	5.11E+03	1.73E+05
Benzene#	6.15E-04	2.26E+00	2.21E+01	1.66E-01	3.27E+00	7.05E+01	2.38E+02
alpha-BHC	1.35E-05	1.04E-02	1.02E-01	9.08E-01	1.89E+02	3.24E-01	1.10E+00
beta-BHC	4.72E-05	3.64E-02	3.56E-01	3.18E+00	6.62E+02	1.14E+00	3.84E+00
delta-BHC	-	-	-	-	-	-	-
gamma-BHC (Lindane)	6.54E-05	5.04E-02	4.93E-01	4.40E+00	9.17E+02	1.57E+00	5.32E+00
Benzo(a)anthracene	1.16E-04	8.97E-02	8.77E-01	7.84E+00	1.63E+03	2.80E+00	9.47E+00
Benzo(a)pyrene	1.16E-05	8.97E-03	8.77E-02	7.84E-01	1.63E+02	2.80E-01	9.47E-01
Benzo(b)fluoranthene	1.16E-04	8.97E-02	8.77E-01	7.84E+00	1.63E+03	2.80E+00	9.47E+00
Benzo(g,h,i)perylene	-	-	-	-	-	-	-
Benzo(k)fluoranthene	1.16E-03	8.97E-01	8.77E+00	7.84E+01	1.63E+04	2.80E+01	9.47E+01
Benzoic Acid	1.46E+02	1.12E+05	1.10E+06	8.18E+06	6.81E+07	2.92E+05	9.87E+06
Benzyl Alcohol	1.09E+01	8.42E+03	8.23E+04	6.13E+05	5.11E+06	2.19E+04	7.41E+05
Beryllium	1.98E-05	1.52E-02	1.49E-01	1.33E+00	2.77E+02	4.75E-01	1.61E+00
bis(2-Chloroethoxy)methane#	-	-	-	-	-	-	-
bis(2-Chloroethyl)ether#	1.56E-05	5.95E-02	5.82E-01	6.29E+00	1.08E+03	1.86E+00	6.28E+00
bis(2-Chloroisopropyl)ether#	4.22E-04	9.36E-01	9.15E+00	4.00E-01	1.70E+04	2.92E+01	9.87E+01
bis(2-Ethylhexyl)phthalate	6.07E-03	4.68E+00	4.57E+01	4.09E+02	8.51E+04	1.46E+02	4.94E+02
Bromodichloromethane#	1.37E-03	1.06E+00	1.03E+01	3.55E-01	1.92E+04	3.30E+01	1.11E+02
Bromoform#	3.81E-03	8.29E+00	8.11E+01	4.52E-02	1.51E+05	2.59E+02	8.98E+02
Bromomethane#	1.09E-02	3.93E+01	3.84E+02	2.86E+03	2.38E+04	1.02E+02	3.84E+03

TABLE 26  
PROGRAMMATIC PRGs FOR ROCKY FLATS PLANT

Target Analyte List Chemical	Residential Groundwater (mg/L)	Residential Surface Water Swimming (mg/L)	Residential Soil (mg/kg)	Office Worker Soil (mg/kg)	Construction Worker Subsurface Soil (mg/kg)	Wading Ecological Worker (mg/L)	Soil Ecological Worker (mg/kg)
4-Bromophenyl phenyl ether	-	-	-	-	-	-	-
2-Butanone#	2.47E+00	1.68E+04	1.65E+05	1.23E+06	1.02E+07	4.38E+04	1.48E+06
Butylbenzylphthalate	7.30E+00	5.62E+03	5.49E+04	4.09E+05	3.41E+06	1.46E+04	4.94E+05
Cadmium	1.82E-02	1.40E+01	1.37E+02	1.02E+03	8.52E+03	3.65E+01	1.23E+03
Calcium	-	-	-	-	-	-	-
Carbon disulfide#	2.76E-02	2.81E+03	2.74E+04	2.04E+05	1.70E+06	7.30E+03	2.47E+05
Carbon tetrachloride#	2.60E-04	5.04E-01	4.93E+00	4.40E+01	1.03E+00	1.57E+01	5.32E+01
Cesium	-	-	-	-	-	-	-
alpha-Chlordane	6.54E-05	5.04E-02	4.93E-01	4.40E+00	9.17E+02	1.57E+00	5.32E+00
beta-Chlordane	6.54E-05	5.04E-02	4.93E-01	4.40E+00	9.17E+02	1.57E+00	5.32E+00
gamma-Chlordane	6.54E-05	5.04E-02	4.93E-01	4.40E+00	9.17E+02	1.57E+00	5.32E+00
4-Chloroaniline	1.46E-01	1.12E+02	1.10E+03	8.18E+03	6.81E+04	2.92E+02	9.87E+03
Chlorobenzene#	5.16E-02	5.62E+02	5.49E+03	4.09E+04	2.11E+01	1.46E+03	4.94E+04
Chloroethane#	2.78E+01	-	-	-	1.77E+03	-	-
Chloroform#	2.76E-04	1.07E+01	1.05E+02	3.49E-02	1.70E+05	3.33E+02	1.13E+03
Chloromethane#	2.32E-03	5.04E+00	4.93E+01	7.44E-02	9.17E+04	1.57E+02	5.32E+02
4-Chloro-3-methylphenol	-	-	-	-	-	-	-
2-Chloronaphthalene#	2.92E+00	2.25E+03	2.20E+04	1.64E+05	1.36E+06	5.84E+03	1.97E+05
2-Chlorophenol#	1.82E-01	1.40E+02	1.37E+03	1.02E+04	8.52E+04	3.65E+02	1.23E+04
4-Chlorophenyl phenyl ether	-	-	-	-	-	-	-
Chromium III	3.65E+01	2.81E+04	2.74E+05	2.04E+06	1.70E+07	7.30E+04	2.47E+06
Chromium VI	1.82E-01	1.40E+02	9.62E+02	4.88E+03	8.52E+04	3.65E+02	1.23E+04
Chrysene	1.16E-02	8.97E+00	8.77E+01	7.84E+02	1.63E+05	2.80E+02	9.47E+02
Cobalt	-	-	-	-	-	-	-
Copper	1.46E+00	1.12E+03	1.10E+04	8.18E+04	6.81E+05	2.92E+03	9.87E+04
Cyanide	7.30E-01	5.62E+02	5.49E+03	4.09E+04	3.41E+05	1.46E+03	4.94E+04
4,4-DDD	3.54E-04	2.73E-01	2.67E+00	2.38E+01	4.97E+03	8.52E+00	2.88E+01
4,4-DDE	2.50E-04	1.93E-01	1.88E+00	1.68E+01	3.51E+03	6.01E+00	2.03E+01
4,4-DDT	2.50E-04	1.93E-01	1.88E+00	1.68E+01	3.51E+03	6.01E+00	2.03E+01
Dibenz(a,h)anthracene	1.16E-05	8.97E-03	8.77E-02	7.84E-01	1.63E+02	2.80E-01	9.47E-01
Dibenzofuran	-	-	-	-	-	-	-
Dibromochloromethane	1.01E-03	7.80E-01	7.62E+00	6.81E+01	1.42E+04	2.43E+01	8.23E+01
Di-n-butylphthalate	3.65E+00	2.81E+03	2.74E+04	2.04E+05	1.70E+06	7.30E+03	2.47E+05
1,2-Dichlorobenzene#	4.76E-01	2.53E+03	2.47E+04	1.84E+05	1.53E+06	6.57E+03	2.22E+05
1,3-Dichlorobenzene#	-	-	-	-	-	-	-
1,4-Dichlorobenzene#	3.54E-03	2.73E+00	2.67E+01	1.37E-01	4.97E+04	8.52E+01	2.88E+02
3,3-Dichlorobenzidine	1.89E-04	1.46E-01	1.42E+00	1.27E+01	2.65E+03	4.54E+00	1.54E+01

TABLE 26  
PROGRAMMATIC PRGs FOR ROCKY FLATS PLANT

Target Analyte List	Residential Groundwater (mg/L)	Residential Surface Water Swimming (mg/L)	Residential Soil (mg/kg)	Office Worker Soil (mg/kg)	Construction Worker Subsurface Soil (mg/kg)	Wading Ecological Worker (mg/L)	Soil Ecological Worker (mg/kg)
Chemical							
1,1-Dichloroethane#	1.01E+00	2.81E+03	2.74E+04	2.04E+05	1.29E+02	7.30E+03	2.47E+05
1,2-Dichloroethane#	1.97E-04	7.20E-01	7.04E+00	5.21E-01	1.31E+04	2.25E+01	7.60E+01
1,1-Dichloroethene#	1.67E-05	1.09E-01	1.07E+00	3.43E+00	1.99E+03	3.41E+00	1.15E+01
1,2-Dichloroethene (total)#	3.28E-01	2.53E+02	2.47E+03	1.84E+04	1.53E+05	6.57E+02	2.22E+04
2,4-Dichlorophenol	1.10E-01	8.42E+01	8.23E+02	6.13E+03	5.11E+04	2.19E+02	7.41E+03
1,2-Dichloropropane#	1.25E-03	9.63E-01	9.42E+00	3.89E-01	1.75E+04	3.01E+01	1.02E+02
cis-1,3-Dichloropropene#	1.27E-04	3.64E-01	3.56E+00	1.03E+00	5.11E+03	1.14E+01	3.84E+01
trans-1,3-Dichloropropene#	1.27E-04	3.64E-01	3.56E+00	1.03E+00	5.11E+03	1.14E+01	3.84E+01
Dieldrin	5.31E-06	4.09E-03	4.00E-02	3.57E-01	7.45E+01	1.28E-01	4.32E-01
Diethylphthalate	2.92E+01	2.25E+04	2.20E+05	1.64E+06	1.36E+07	5.84E+04	1.97E+06
2,4-Dimethylphenol#	7.30E-01	5.62E+02	5.49E+03	4.09E+04	3.41E+05	1.46E+03	4.94E+04
Dimethylphthalate	3.65E+02	2.81E+05	2.74E+06	2.04E+07	1.70E+08	7.30E+05	2.47E+07
4,6-Dinitro-2-methylphenol#	-	-	-	-	-	-	-
2,4-Dinitrophenol	7.30E-02	5.62E+01	5.49E+02	4.09E+03	3.41E+04	1.46E+02	4.94E+03
2,4-Dinitrotoluene	7.30E-02	5.62E+01	5.49E+02	4.09E+03	3.41E+04	1.46E+02	4.94E+03
2,6-Dinitrotoluene	3.65E-02	2.81E+01	2.74E+02	2.04E+03	1.70E+04	7.30E+01	2.47E+03
Di-n-octylphthalate	7.30E-01	5.62E+02	5.49E+03	4.09E+04	3.41E+05	1.46E+03	4.94E+04
Endosulfan I	1.83E-03	1.40E+00	1.37E+01	1.02E+02	8.52E+02	3.65E+00	1.23E+02
Endosulfan II	1.83E-03	1.40E+00	1.37E+01	1.02E+02	8.52E+02	3.65E+00	1.23E+02
Endosulfan sulfate	1.83E-03	1.40E+00	1.37E+01	1.02E+02	8.52E+02	3.65E+00	1.23E+02
Endosulfan (technical)	1.83E-03	1.40E+00	1.37E+01	1.02E+02	8.52E+02	3.65E+00	1.23E+02
Endrin ketone	-	-	-	-	-	-	-
Endrin (technical)	1.09E-02	8.42E+00	8.23E+01	6.13E+02	5.11E+03	2.19E+01	7.41E+02
Ethylbenzene#	1.58E+00	2.81E+03	2.74E+04	2.04E+05	1.52E+03	7.30E+03	2.47E+05
Fluoranthene	1.46E+00	1.12E+03	1.10E+04	8.18E+04	6.81E+05	2.92E+03	9.87E+04
Fluorene#	1.46E+00	1.12E+03	1.10E+04	8.18E+04	6.81E+05	2.92E+03	9.87E+04
Heptachlor	1.89E-05	1.46E-02	1.42E-01	1.27E+00	2.65E+02	4.54E-01	1.54E+00
Heptachlor epoxide	9.34E-06	7.20E-03	7.04E-02	6.29E-01	1.31E+02	2.25E-01	7.60E-01
Hexachlorobenzene	5.31E-05	4.09E-02	4.00E-01	3.57E+00	7.45E+02	1.28E+00	4.32E+00
Hexachlorobutadiene	-	-	-	2.60E+06	5.40E+08	-	-
Hexachlorocyclopentadiene	2.56E-01	1.97E+02	1.92E+03	1.42E+04	1.19E+05	5.11E+02	1.73E+04
Hexachloroethane	6.07E-03	4.68E+00	4.57E+01	4.09E+02	1.70E+04	7.30E+01	4.94E+02
2-Hexanone#	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	1.16E-04	8.97E-02	8.77E-01	7.84E+00	1.63E+03	2.80E+00	9.47E+00
Iron	-	-	-	-	-	-	-
Isophorone	8.95E-02	6.89E+01	6.74E+02	6.02E+03	1.25E+06	2.15E+03	7.41E+03
Lead	-	-	-	-	-	-	-

TABLE 26  
PROGRAMMATIC PRGS FOR ROCKY FLATS PLANT

Target Analyte List	Residential Groundwater (mg/L)	Residential Surface Water Swimming (mg/L)	Residential Soil (mg/kg)	Office Worker Soil (mg/kg)	Construction Worker Subsurface Soil (mg/kg)	Wading Ecological Worker (mg/L)	Soil Ecological Worker (mg/kg)
Lithium	-	-	-	-	-	-	-
Magnesium	-	-	-	-	-	-	-
Manganese	1.82E-01	1.40E+02	1.37E+03	1.01E+04	8.52E+04	3.65E+02	1.23E+04
Mercury	1.09E-02	8.42E+00	8.23E+01	6.13E+02	5.11E+03	2.19E+01	7.41E+02
Methoxychlor	1.82E-01	1.40E+02	1.37E+03	1.02E+04	8.52E+04	3.65E+02	1.23E+04
Methylene chloride#	6.22E-03	8.73E+00	8.54E+01	4.29E-02	1.59E+05	2.73E+02	9.22E+02
2-Methylnaphthalene#	-	-	-	-	-	-	-
4-Methyl-2-pentanone#	1.98E-01	1.40E+03	1.37E+04	1.02E+05	8.52E+05	3.65E+03	1.23E+05
2-Methylphenol	1.83E+00	1.40E+03	1.37E+04	1.02E+05	8.52E+05	3.65E+03	1.23E+05
4-Methylphenol	1.82E-01	1.40E+02	1.37E+03	1.02E+04	8.52E+04	3.65E+02	1.23E+04
Molybdenum	1.82E-01	1.40E+02	1.37E+03	1.02E+04	8.52E+04	3.65E+02	1.23E+04
Naphthalene#	1.46E+00	1.12E+03	1.10E+04	8.18E+04	6.81E+05	2.92E+03	9.87E+04
Nickel	7.30E-01	5.62E+02	5.49E+03	4.09E+04	3.41E+05	1.46E+03	4.94E+04
2-Nitroaniline	-	-	-	-	-	-	-
3-Nitroaniline	-	-	-	-	-	-	-
4-Nitroaniline	-	-	-	-	-	-	-
Nitrobenzene#	4.26E-03	1.40E+01	1.37E+02	1.02E+03	8.52E+03	3.65E+01	1.23E+03
2-Nitrophenol	-	-	-	-	-	-	-
4-Nitrophenol#	-	-	-	-	-	-	-
n-Nitrosodiphenylamine#	1.73E-02	1.34E+01	1.31E+02	2.80E-02	2.43E+05	4.17E+02	1.41E+03
n-Nitrosodipropylamine	1.21E-05	9.36E-03	9.15E-02	8.17E-01	1.70E+02	2.92E-01	9.87E+01
Pentachlorophenol	7.08E-04	5.46E-01	5.34E+00	4.77E+01	9.93E+03	1.70E+01	5.76E+01
Phenanthrene#	-	-	-	-	-	-	-
Phenol	2.19E+01	1.68E+04	1.65E+05	1.23E+06	1.02E+07	4.38E+04	1.48E+06
Potassium	-	-	-	-	-	-	-
Pyrene	1.09E+00	8.42E+02	8.23E+03	6.13E+04	5.11E+05	2.19E+03	7.41E+04
Selenium	1.82E-01	1.40E+02	1.37E+03	1.02E+04	8.52E+04	3.65E+02	1.23E+04
Silver	1.82E-01	1.40E+02	1.37E+03	1.02E+04	8.52E+04	3.65E+02	1.23E+04
Sodium	-	-	-	-	-	-	-
Strontium	2.19E+01	1.68E+04	1.65E+05	1.23E+06	1.02E+07	4.38E+04	1.48E+06
Styrene#	2.01E+00	5.62E+03	5.49E+04	4.09E+05	3.41E+06	1.46E+04	4.94E+05
1,1,2,2-Tetrachloroethane#	8.95E-05	3.28E-01	3.20E+00	1.14E+00	5.96E+03	1.02E+01	3.46E+01
Tetrachloroethene#	1.43E-03	1.26E+00	1.23E+01	2.97E-01	4.94E+01	3.93E+01	1.33E+02
Thallium	-	-	-	-	-	-	-
Tin	2.19E+01	1.68E+04	1.65E+05	1.23E+06	1.02E+07	4.38E+04	1.48E+06
Toluene#	9.65E-01	5.62E+03	5.49E+04	4.09E+05	2.94E+02	1.46E+04	4.94E+05
Toxaphene	7.73E-05	5.95E-02	5.82E-01	5.20E+00	1.08E+03	1.86E+00	6.28E+00

TABLE 26  
PROGRAMMATIC PRGs FOR ROCKY FLATS PLANT

Target Analyte List	Residential Groundwater (mg/L)	Residential Surface Water Swimming (mg/L)	Residential Soil (mg/kg)	Office Worker Soil (mg/kg)	Construction Worker Subsurface Soil (mg/kg)	Wading Ecological Worker (mg/L)	Soil Ecological Worker (mg/kg)
Chemical							
1,2,4-Trichlorobenzene#	2.34E-02	2.81E+02	2.74E+03	2.04E+04	1.70E+05	7.30E+02	2.47E+04
1,1,1-Trichloroethane#	-	-	-	-	-	-	-
1,1,2-Trichloroethane#	3.18E-04	1.15E+00	1.12E+01	3.26E-01	2.09E+04	3.59E+01	1.21E+02
Trichloroethene#	2.55E-03	5.95E+00	5.82E+01	6.29E-02	1.08E+05	1.86E+02	6.28E+02
2,4,5-Trichlorophenol	3.65E+00	2.81E+03	2.74E+04	2.04E+05	1.70E+06	7.30E+03	2.47E+05
2,4,6-Trichlorophenol	7.73E-03	5.95E+00	5.82E+01	5.20E+02	1.08E+05	1.86E+02	6.28E+02
Vanadium	2.56E-01	1.97E+02	1.92E+03	1.43E+04	1.19E+05	5.11E+02	1.73E+04
Vinyl acetate	3.65E+01	2.81E+04	2.74E+05	2.04E+06	1.70E+07	7.30E+04	2.47E+06
Vinyl chloride#	2.81E-05	3.45E-02	3.37E-01	1.09E+01	6.27E+02	1.08E+00	3.64E+00
Xylene (total)#	7.30E+01	5.62E+04	5.49E+05	4.09E+06	3.41E+07	1.46E+05	4.94E+06
Zinc	1.09E+01	8.42E+03	8.23E+04	6.13E+05	5.11E+06	2.19E+04	7.41E+05
Nitrate	5.84E+01	4.49E+04	4.39E+05	3.27E+06	2.73E+07	1.17E+05	3.95E+06
Nitrite	3.65E+00	2.81E+03	2.74E+04	2.04E+05	1.70E+06	7.30E+03	2.47E+05
pH	-	-	-	-	-	-	-
Sulfide	-	-	-	-	-	-	-
Ammonium	-	-	-	-	-	-	-
Bicarbonate	-	-	-	-	-	-	-
Bromide	-	-	-	-	-	-	-
Carbonate	-	-	-	-	-	-	-
Chloride	-	-	-	-	-	-	-
Cyanide	-	-	-	-	-	-	-
Fluoride	2.19E+00	1.68E+03	1.65E+04	1.23E+05	1.02E+06	4.38E+03	1.48E+05
Orthophosphate	-	-	-	-	-	-	-
Silica (as Si and SiO <sub>2</sub> )	-	-	-	-	-	-	-
Sulfate	-	-	-	-	-	-	-
Americium-241	1.98E-01 *	1.53E+02 *	2.37E+00 **	9.55E+00 **	6.50E+02 **	4.76E+03 *	1.09E+01 **
Cesium-137	1.70E+00 *	1.31E+03 *	2.83E+01 **	1.14E+02 **	2.38E+04 **	4.08E+04 *	1.38E+02 **
Plutonium-239	2.07E-01 *	1.59E+02 *	3.43E+00 **	1.38E+01 **	2.85E+03 **	4.97E+03 *	1.67E+01 **
Plutonium-240	2.07E-01 *	1.59E+02 *	3.42E+00 **	1.38E+01 **	2.83E+03 **	4.97E+03 *	1.67E+01 **
Radium-226	3.97E-01 *	3.05E+02 *	2.28E+00 **	9.13E+00 **	3.27E+02 **	9.52E+03 *	9.70E+00 **
Radium-228	4.76E-01 *	3.66E+02 *	7.93E+00 **	3.20E+01 **	6.67E+03 **	1.14E+04 *	3.86E+01 **
Strontium-89	1.59E+01 *	1.22E+04 *	6.64E+01 **	2.66E+02 **	8.53E+03 **	3.81E+05 *	2.78E+02 **
Strontium-90	1.44E+00 *	1.11E+03 *	2.40E+00 **	9.70E+01 **	2.02E+04 **	3.46E+04 *	2.78E+02 **

TABLE 26  
PROGRAMMATIC PRGs FOR ROCKY FLATS PLANT

Target Analyte List Chemical	Residential Groundwater (mg/L)	Residential Surface Water Swimming (mg/L)	Residential Soil (mg/kg)	Office Worker Soil (mg/kg)	Construction Worker Subsurface Soil (mg/kg)	Wading Ecological Worker (mg/L)	Soil Ecological Worker (mg/kg)
Tritium	8.82E+02 *	6.78E+05 *	1.47E+04 **	5.93E+04 **	1.23E+07 **	2.12E+07 *	7.16E+04 **
Uranium-233	2.98E+00 *	2.29E+03 *	4.47E+01 **	1.82E+02 **	2.84E+04 **	7.14E+04 *	2.18E+02 **
Uranium-234	2.98E+00 *	2.29E+03 *	4.53E+01 **	1.85E+02 **	3.09E+04 **	7.14E+04 *	2.22E+02 **
Uranium-235	2.98E+00 *	2.29E+03 *	1.73E-01 **	6.92E-01 **	1.74E+01 **	7.14E+04 *	6.92E-01 **
Uranium-238	2.98E+00 *	2.29E+03 *	4.60E+01 **	1.87E+02 **	3.33E+04 **	7.14E+04 *	2.25E+02 **

# = Chemicals listed are volatile.

\* = Values given are in units of pCi/L.

\*\* = Values given are in pCi/g.

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## APPENDIX F. SEDIMENTS AND SURFACE WATER MAPS

Appendix F contains maps showing the concentrations and activities of selected metals and radionuclides at each sampling location for sediments (grab samples only) and surface water. These maps were used for spatial analysis of concentration and activity patterns to determine if patterns indicated deposition of contamination or natural variability. The following figures illustrate the spatial distribution of selected metals, as well as plutonium, americium, and uranium, in sediments and surface water:

- Figure F-1 – IHSS 200 – Stream and Reservoir Sediments (arsenic, beryllium, calcium, chromium, iron, manganese, potassium, and zinc)
- Figure F-2 – IHSS 201 – Stream and Reservoir Sediments (arsenic, beryllium, calcium, chromium, iron, manganese, potassium, and zinc)
- Figure F-3 – IHSS 202 – Stream and Reservoir Sediments (arsenic, beryllium, calcium, chromium, iron, manganese, potassium, and zinc)
- Figure F-4 – IHSS 200 – Stream and Reservoir Sediments ( $^{241}\text{Am}$ ,  $^{239/240}\text{Pu}$ ,  $^{233/234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ )
- Figure F-5 – IHSS 201 – Stream and Reservoir Sediments ( $^{241}\text{Am}$ ,  $^{239/240}\text{Pu}$ ,  $^{233/234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ )
- Figure F-6 – IHSS 202 – Stream and Reservoir Sediments ( $^{241}\text{Am}$ ,  $^{239/240}\text{Pu}$ ,  $^{233/234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ )
- Figure F-7 – IHSS 200 – Stream and Reservoir Surface Water (arsenic, beryllium, calcium, chromium, iron, manganese, potassium, and zinc)

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- Figure F-8 – IHSS 201 – Stream and Reservoir Surface Water (arsenic, beryllium, calcium, chromium, iron, manganese, potassium, and zinc)
- Figure F-9 – IHSS 202 – Stream and Reservoir Surface Water (arsenic, beryllium, calcium, chromium, iron, manganese, potassium, and zinc)

The metals arsenic, beryllium, and manganese have been eliminated as COCs by the weight-of-evidence evaluation (Section 5.0; Table 5-1). The remaining metals are shown as examples of chemicals eliminated by earlier COC steps.

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## APPENDIX G. PROBABILITY PLOT ANALYSIS

A probability plot analysis was performed on selected chemicals in surface sediments and surface water to assess whether a chemical concentration/activity data set (i.e., population) represents either a background (natural or anthropogenic in the case of global fallout of radionuclides) or contaminated population. A contaminated population may indicate the chemical is a chemical of concern (COC). This analysis was performed using a statistical software program called PROBPLOT. PROBPLOT was used to define the number of populations present and the concentration/activity range for each population. A description of the results and methods of the probability plot analysis are presented in this appendix.

The analysis indicated the presence of one statistically normal population for each of the metals and radionuclides in each of the IHSS with the exception of aluminum, chromium, manganese, and <sup>239/240</sup>Pu in Mower Reservoir (IHSS 202) and chromium in Great Western Reservoir (IHSS 200) (Table G-1). In these cases where two populations were identified, the concentration/activity variations represent subpopulations within the population and are attributed to geochemical (complexation, adsorption, dissolution, precipitation), organic (aquatic organisms, plants, and detritus), and physical processes (transport and deposition) that collectively cause natural variability. The final decision whether a chemical is a COC will be made after reviewing the other weight-of-evidence evaluation results.

A more detailed description of the results and methods employed in the evaluation is included in this appendix, which is divided into the following sections:

- PROBPLOT Procedure (Section G.2)
- Data Input (Section G.3)
- Data Interpretation for Sediments (Section G.4)
- Data Interpretation for Surface Water (Section G.5)
- PROBPLOT Output (Section G.6)
- References

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**TABLE G-1**  
**RESULTS OF PROBABILITY PLOT ANALYSIS**  
**NUMBER OF DATA POPULATIONS**

Chemical	Surface Sediments IHSS			Surface Water
	200	201	202	IHSSs Combined
Aluminum	1	1	2 <sup>N</sup>	--
Arsenic	1	1	1	1
Beryllium	1	1	1	--
Cadmium	1	1	1	--
Chromium	2 <sup>N</sup>	1	2 <sup>N</sup>	--
Cobalt	1	1	1	--
Iron	1	1	1	1
Lead	1	1	1	1
Lithium	1	1	1	--
Manganese	1	1	2 <sup>N</sup>	1
Mercury	1	1	1	--
Nickel	1	1	1	--
Silicon	1	1	1	1
Zinc	1	1	1	--
<sup>239/240</sup> Pu	1	1	2 <sup>N</sup>	--
<sup>233/234</sup> U	1	1	1	--
<sup>234</sup> U	1	1	1	--

**Notes:**

- = Analysis not performed.

One population may indicate chemical is not a COC. Population represents background conditions.

Two or more populations may indicate chemical is a COC.

N = Second population is attributed to natural background processes.

Chemical does not appear to be a COC.

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## G.2 PROBPLOT PROCEDURE

PROBPLOT is an interactive software tool (Stanley, 1987) that allows a user to statistically evaluate cumulative frequency distributions for a given data set. The PROBPLOT analysis determines the number of populations and statistical boundaries present. The software program was used to evaluate the concentration/activity distributions of specific metals and radionuclides contained in sediment and surface water samples at OU 3. The distribution information was used to define the number of populations present and the concentration range for each population and each metal/radionuclide data set. PROBPLOT has been used at the Operating Industries, Inc. (OII) Superfund site (EPA, 1994), the Lawrence Livermore National Laboratory (DOE, 1994), and has been used extensively by the mining industry for over 20 years to identify geochemical anomalies for exploration (Sinclair, 1986; Sinclair, 1976; Stanley, 1987).

The computer analysis in PROBPLOT compares the actual cumulative frequency distribution for given data sets with that of a normally distributed population. In a cumulative frequency distribution, the concentration frequencies of a distribution are cumulated from low to high values. Cumulating from low to high produces a "less than" distribution where each cumulative frequency includes all concentrations/activities that are less than a given value. The model is flexible; it is capable of representing numerous forms of frequency distributions consisting of combinations of normal or lognormal component populations.

PROBPLOT generates a probability plot that presents the distribution for each population identified within a data set. The mean plus two standard deviations (i.e., threshold) value is also summarized for each population.

## G.3 DATA INPUT

Metal and radionuclide concentrations/activities from the surface-sediment and surface-water samples collected from Great Western Reservoir (IHSS 200), Standley Lake (IHSS 201), and Mower Reservoir (IHSS 202) for the RFI/RI for OU 3 were analyzed using PROBPLOT. Surface-sediment samples, collected in each reservoir and in the adjoining creeks for each of the IHSSs,

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were used in the PROBLOT analyses. Only concentration data reported above the detection limit (i.e., detects) were used in the PROBLOT analysis. The concentration/activity data were logtransformed before being input into PROBLOT because natural environments are typically lognormally distributed (Rose, 1979). If multiple samples were collected at a given location, the data values for the additional samples were averaged prior to analysis. However, for Mower Reservoir, if a given location was sampled more than once, the samples were treated as individual samples and not averaged. This was done in order to have a sufficient number of data points for the PROBLOT analysis. (A minimum of 15 points is required by the PROBLOT program to define populations [Stanley, 1987].) The following metals and radionuclides for sediments at each IHSS were evaluated:

- Aluminum
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Iron
- Lead
- Lithium
- Manganese
- Mercury
- Nickel
- Silicon
- Zinc
- $^{233/234}\text{U}$
- $^{235}\text{U}$
- $^{239/240}\text{Pu}$

A probability plot for every metal is not included in this appendix. A subset was selected based on their potential toxicity. Additional metals were selected to provide information on the potential geochemical association with other metals or processes. For example, cobalt and nickel are similar in chemical behavior. Therefore, information on each of these metals can be used to confirm the conclusions made.

Surface-water samples were collected in the streams upgradient to RFP to establish background levels. The background data sets were collected from areas considered unimpacted by RFP activities and are described in the Background Geochemical Characterization Report (DOE, 1993). If more than one sample was collected at a given location for either the background or the OU 3 data, each value was used as part of the data set. No averaging of the data was

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performed. Only detected data were used in the analysis. Surface-water data collected (creek and reservoir data) for the three IHSSs (Great Western Reservoir-200, Standley Lake-201, and Mower Reservoir-202) were combined with background data to determine if more than one population was present. The background and OU 3 surface-water data were combined to have a sufficient number of samples (i.e., 15 or greater) because some of the metals had low detection frequencies. Probability plots were generated for arsenic, lead, manganese, iron, and silicon. These metals were selected based on their toxicity factors and potential association with other metals and geochemical processes.

#### G.4 DATA INTERPRETATION FOR SEDIMENTS

This section presents the interpretation of the probability plots for the surface-sediment data. Based on the PROBLOT analysis, the chemicals in the OU 3 surface sediment exhibit low concentrations/activities of naturally occurring metals and radionuclides and appear to represent a single, background population (see Table G-1). This subsection provides an example of a chemical exhibiting a population that appears to represent contamination, brief descriptions of the processes that cause variability within a natural background population, and the results for each metal/radionuclide evaluated.

For OU 3 sediments, the metal/radionuclide analytical results for samples from each of the three reservoirs were evaluated separately. However, the creek sediment data associated with each reservoir were included with reservoir sediments in the data sets. This was done in order to evaluate the complete physical system of the reservoir.

Geochemical evaluations (of all the metals/radionuclides in total), the low concentrations present, geologic setting, and available background and benchmark data indicate the population identified in PROBLOT represents a statistically normal background population.

Where more than one population is identified in PROBLOT, the two populations can either represent background and contamination (depending on the magnitude of differences for each population) or represent natural physical processes within the background population that result

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in a concentration/activity slightly elevated above the upper limit background concentration/activity.

To illustrate a scenario where a probability plot shows two populations that represent one background population and one contamination population, the OU 3  $^{239/240}\text{Pu}$  data from surface-soil samples were evaluated. Based on the Gilbert statistical analysis (see Subsection 4.3), some of the soil sample activity values were above background; however, most were below background. Therefore, the OU 3 soil sample results represent two populations (one background and one with elevated  $^{239/240}\text{Pu}$  activities). The data set used for the PROBPLOT analysis included the OU 3 RFI/RI soil plots plus the Jefferson County Remedy Acres samples.

The histogram and probability plot for the soil data clearly show two separate populations (see Figures G-1 and G-2a). The statistically defined threshold level (defined as the mean plus two standard deviations) is the activity at which background is exceeded in the cumulative frequency distribution and is 0.07 pCi/g for this data set. This value compares favorably with the background mean plus two standard deviations of 0.09 pCi/g that was calculated using the surface-soil background data.

In reviewing the soil probability plot (Figure G-2a), it is important to note that the two population distributions *diverge* with increasing plutonium activities rather than *converge*. In the OU 3 sediment data sets where two populations are identified (for example, aluminum for IHSS 202), the populations *converge* at higher concentrations/activities (Figure G-2b). The convergence of the upper and lower populations indicates that, unlike the diverging populations, these represent two subpopulations of a single (background) population. The upper subpopulation represents a concentration/activity range of values resulting from precipitation or adsorption of the individual metal/radionuclide. As a comparison, aluminum in Great Western Reservoir (IHSS 202) represents a single, background population (Figure G-2c).

In the sediment PROBPLOT results, most of the plots for a given metal/radionuclide show all the data for an IHSS to be below the threshold value (clearly indicating one population). In the cases where more than one population is identified, the threshold values for the two



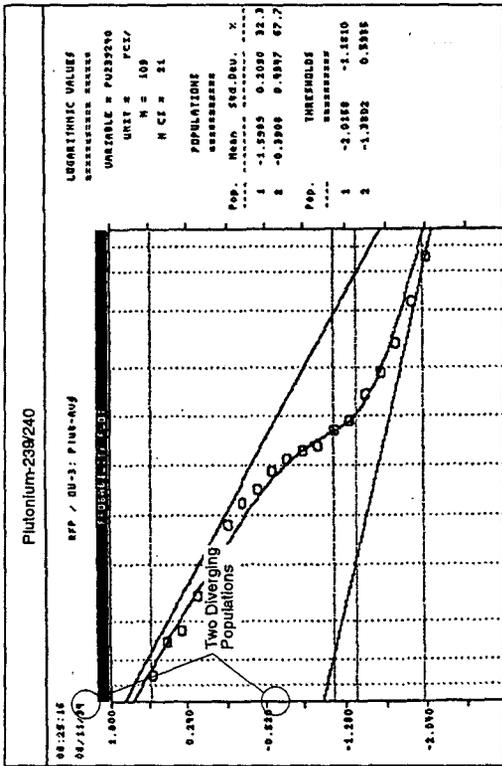


Figure G-2a  
TWO DIVERGING POPULATIONS  
PLUTONIUM IN SURFACE SOIL  
IHSS 199

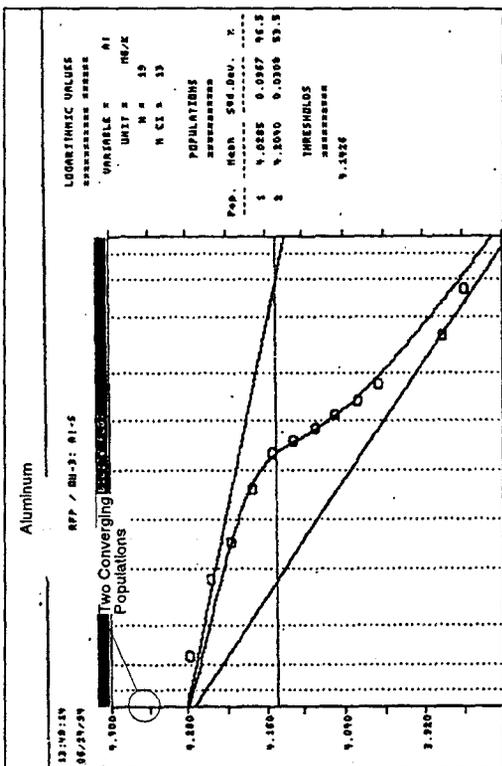


Figure G-2b  
TWO CONVERGING POPULATIONS  
ALUMINUM IN SURFACE SEDIMENTS  
MOWER RESERVOIR (IHSS 202)

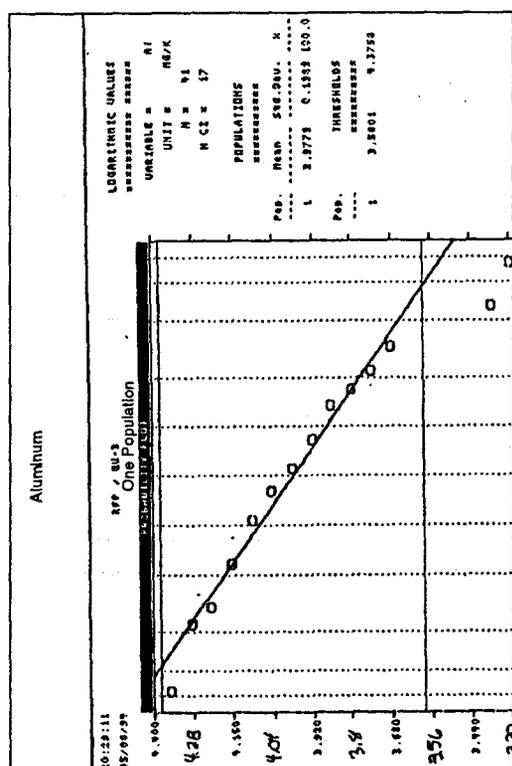


Figure G-2c  
ONE POPULATION  
ALUMINUM IN SURFACE SEDIMENTS  
GREAT WESTERN RESERVOIR (IHSS 200)

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populations are similar (indicating the second population is due to natural processes and not contamination).

The overall OU 3 data sets exhibit a range of concentrations/activities within expected natural ranges for sediment data, as seen in the benchmark comparison described in previous sections of TM 4. The logarithmic values for the metals and the radionuclides evaluated range from approximately -0.4 to almost 5; yet the logarithmic values of the standard deviations range from only 0.1 to 0.4 with an average of approximately 0.25. In other words, there is little variation from the mean concentrations/activities, regardless of the value of the mean metal or radionuclide concentration/activity for the OU 3 sediments. If concentration levels were the result of contamination, there would be higher standard deviations for the contaminating constituents (Rose et al., 1979). These small, similar standard deviations suggest that the sediments probably represent background conditions and are within naturally expected variability.

#### G.4.1 Reasons for Naturally Occurring Variability

Several physiochemical processes cause variability in sediments in nature, depending on geologic setting. The predominant processes causing variability within OU 3 sediments are described in the following paragraphs.

##### Geochemical Processes

The sediment grab samples were collected from both the streams draining into the reservoir and the reservoir itself. Within the reservoir, sediment samples were collected from both peripheral (inlets, shoreline, and adjacent to the dam) and central parts of the reservoir. Each of the individual sediment sample locations represent unique local environments with differing microbiota, physicochemical conditions, water depth, and flow regimes. Each environment results in spatially variable concentrations of metals and/or radionuclides. For example, streams have significantly higher flow velocities than reservoirs; this generally results in coarser-grained sediment, oxygenated water (i.e., oxidizing oxidation-reduction (Eh) conditions), near-neutral pH, and a highly variable aerobic microbiotic and aquatic population (Rose et al., 1979).

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Coarse-grained sediments typically have lower metal concentrations in comparison to finer-grained sediments because of the lower surface area for a given volume of sediment; this results in a lower number of sorption sites (Davis and Kent, 1990). Oxidizing conditions with near-neutral pH minimizes the dissolved metals concentrations because metals are least soluble in these environmental conditions (Rose et al., 1979). Compared to the reservoir sediments, the stream sediments have a very low total organic carbon (TOC) and nutrient load; thus, less chemical reactions with organics occur. As a result, lower metal concentrations are expected.

### Physical Processes

Shoreline peripheral sediments primarily reflect the local land use, soils, and bedrock composition. The sediment composition can be highly variable because of surface-water runoff, such as irrigation return flow, industrial outfalls, return rills, and sheetflow into the reservoir. Reservoir sediments in the nearshore area (littoral) are generally finer-grained than stream sediments, but much coarser than either the central reservoir or in the area adjacent to the dam.

The central area of the reservoir and the area adjacent to the dam receive the finest-grained material. As a stream enters a reservoir, a deltaic environment at the inlet of the reservoir is created wherein the coarser-grained sediments settle near the inlet as the flow velocity decreases. Finer-grained sediments are transported farther into the reservoir. The finer-grained sediments are a mixture of clay minerals, natural organic acids (humic and fulvic), and iron, manganese, and aluminum oxyhydroxide flocculants (Davis and Kent, 1990). Both the organic acids and the oxyhydroxide flocculants contain variable concentrations of complexed and adsorbed metals (Rose et al., 1979). Generally, only the finest-grained material reaches the reservoir area nearest the dam (the deepest portion of the reservoir).

### Organic Processes

In addition, algal growth in the reservoir can change the pH (and to an extent, the Eh) of the reservoir water on not only a seasonal, but also a diurnal, cycle. The pH of reservoir water can change from a near-neutral pH of 7 during darker hours to a more alkaline pH of 8.5 to 9 during

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the daylight hours (Hem, 1985). This cycle can cause a change in dissolved (at near-neutral pH) versus precipitated (more alkaline pH) metal concentrations. Carbonate minerals (calcium, iron, and, potentially, magnesium and manganese) can be precipitated and become part of the sediments on both diurnal and seasonal cycles, thus causing temporal variations in concentrations (Hem, 1985).

Variability in concentrations/activity can also be caused by how the sample is collected and what materials compose the sample. For example, the more organic-enriched and fine-grained materials in the sample, the greater the concentration of metals (Rose et al., 1979).

As the above discussion illustrates, the variability in stream and reservoir sediment environmental conditions (i.e., sample locations) can result in a concentration/activity range of values within a statistically normal background population; that is, these processes cause natural variability within a population without any contribution from a potential contaminant. When statistically evaluated using cumulative frequency distributions, one population or several subpopulations that are a result of these physiochemical processes may be identified. Two populations may also be identified with one population representing background and one population representing contamination, as seen in the soil plot example in Figures G-1 and G-2. As described in the following paragraphs, most of the metals and radionuclides are defined by a single (low concentration range, similar to benchmark ranges) population that defines background concentration/activity ranges. Each reservoir also has environmental characteristics that cause some differences in concentration and characteristics. These result from natural variation attributable to the physiochemical factors described above.

The PROBPLOT results for each metal and radionuclide that was evaluated are discussed in the following paragraphs. PROBPLOT output for each metal and radionuclide for each IHSS is included in Subsection G.6.

#### **G.4.2 Aluminum**

Aluminum is the third most abundant element in the earth's crust (Hem, 1985). Based on the probability plots, one population was identified for Great Western Reservoir and one for

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**Standley Lake.** In Mower Reservoir, two populations were identified. The two populations in Mower Reservoir are most likely the result of organic processes occurring in the reservoir and represent subpopulations within a background population, as described in the following paragraphs.

Mower Reservoir sediments have the highest mean and median concentrations (13,300 and 14,600 mg/kg, respectively) but the lowest maximum concentration (18,300 mg/kg) of the three reservoirs. The small range of aluminum concentrations (less than an order of magnitude) between the mean, median, and maximum values indicates physiochemical processes are occurring in Mower Reservoir, thus causing two subpopulations. If contamination were present, a larger difference in the mean, median, and maximum would be expected. This small range in aluminum concentrations and similarity in threshold values for each population is shown on the probability plot by the subpopulations converging at higher concentrations.

In Mower Reservoir, pH fluctuations and algal growth have been observed. The higher pH generated by algae in Mower Reservoir results in clay minerals precipitating out of solution more readily than in the other two reservoirs. Therefore, algal activity increases aluminum concentrations. The kinetics of clay-mineral precipitation increase with pHs above 8 (Stumm, 1990). The clay precipitation also enhances the potential for coprecipitation of metals (calcium, magnesium, sodium, iron, and lithium) into the Mower Reservoir sediments (Deer et al., 1971).

Based on the varying pH in Mower Reservoir, the similarity of the two populations within Mower Reservoir, and the similarity of Great Western Reservoir and Standley Lake, it is most probable that the aluminum in Mower Reservoir sediments represents natural variability within background (two subpopulations within background), and is not representative of a contamination source.

#### **G.4.3 Arsenic**

One population was identified for arsenic in each of the three reservoirs, with little difference in arsenic concentrations in Great Western Reservoir and Mower Reservoir; their respective means

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were 4.7 and 4.8 mg/kg and their respective maximums were 9.4 and 10 mg/kg. Standley Lake has essentially the same mean (5.0 mg/kg) but almost twice the maximum concentration (19 mg/kg) compared to Great Western Reservoir and Mower Reservoir. However, Standley Lake also receives sediments from the highly mineralized Clear Creek drainage, which may account for the higher maximum concentration. The similar mean concentrations of arsenic for the three reservoirs, coupled with the single population defined by the PROBPLOT analysis for all three reservoirs, indicates a common background population.

#### G.4.4 Beryllium

Beryllium in sediments shows no difference in mean (0.78, 0.59, and 0.95 mg/kg for IHSSs 200, 201, and 202, respectively), standard deviation (1.45, 1.84, and 1.47 mg/kg for IHSSs 200, 201, and 202, respectively), and median (0.83, 0.6, 1.1 mg/kg for IHSSs 200, 201, and 202, respectively) concentrations between the three reservoirs. The probability plots for each reservoir also indicate only one population. Because only one population was identified and the concentrations are low (less than 2.1 mg/kg and similar to benchmark data), the beryllium concentrations in sediment represent a background population.

#### G.4.5 Cadmium

In Great Western Reservoir and Standley Lake, only one population was identified for cadmium, based on the probability analysis. PROBPLOT was not performed for Mower Reservoir because cadmium was not detected in any of the samples. The PROBPLOT results also show all the data for a given IHSS were below the threshold value defined from the cumulative frequency distribution. Cadmium occurs naturally in the surrounding mineralized areas (Sheridan et al., 1967).

#### G.4.6 Chromium

The PROBPLOT analysis indicates two subpopulations of chromium were identified for Mower Reservoir and Great Western Reservoir but only one population for Standley Lake. In February 1989, a waste chromic acid spill occurred at the RFP. An estimated 750 gallons of chromic

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acid were discharged into a drain system that flowed to the plant's sewage treatment plant. The chromic acid went through the treatment plant and was discharged to retention pond B-3 (CDPHE, 1994). According to the Phase 1 Health Studies on RFP, "No documentation of off-site contamination was located for the event" (CDPHE, 1994). If releases did occur offsite, Great Western Reservoir would have been the receiving reservoir and its sediments should have the highest chromium concentrations. However, chromium was detected in the highest concentrations in Standley Lake (31.9 mg/kg), and Mower Reservoir (14 mg/kg) had the highest mean concentration. In Great Western Reservoir, the mean and maximum concentrations of chromium were 9.1 mg/kg and 17.9 mg/kg, respectively.

Two subpopulations representing background have been identified in Great Western Reservoir and Mower Reservoir. The two subpopulations (the lower and upper subpopulation distributions) have essentially the same 95th percentile chromium concentration (24.9 and 21.7 mg/kg, respectively, for Great Western Reservoir and 17.6 and 17.6 mg/kg, respectively, for Mower Reservoir). Furthermore, the higher concentration population for each has a lower slope than the lower population (the population distributions converge at the 95-percentile concentration). The upper subpopulation is likely caused by physiochemical processes such as adsorption or precipitation, organic absorption, or algal or microbial bioaccumulation.

The high algal content in Mower Reservoir suggests that *organic complexing and absorption*, coupled with pH and Eh conditions imposed by the organics, are probably responsible for the two chromium subpopulations. Chromium has a tendency to be cycled by the diurnally changing pH and Eh conditions imposed by the algal organisms. This cycle can cause a change in dissolved versus precipitated metal concentrations.

The micas derived from the pegmatites in the adjacent drainages are the most likely source of chromium-rich micas (Deer et al., 1971).

A comparison of the three reservoir means and medians and probability plots indicates that each reservoir is a normal background population.

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#### **G.4.7 Cobalt**

Based on the probability plots, one population was identified for each of the three reservoirs. Cobalt concentrations in sediments are essentially the same as the nickel concentrations divided by a value of approximately 2 in all three sediment areas. This close association between cobalt and nickel is common in sediments, regardless of source, because of the similarity in the chemical behavior of the two metals (Deer et al., 1971). This relationship in all three reservoirs indicates that the population represents a background population.

#### **G.4.8 Iron**

One population was identified in each reservoir for iron, based on the PROBLOT analysis. Iron has the second highest metal concentration range in the sediments. Relatively high iron concentrations are typical for sediments from lacustrine environments because the reservoirs collect the iron oxyhydroxide precipitates, and the lacustrine organisms, particularly algae, utilize iron in their metabolic processes. This promotes and retains iron concentrations in the reservoir (Davis and Kent, 1990). There is a seasonal die-off of aquatic organisms, which incorporates a major part of the retained iron into the sediments. The means (16,400, 13,120, and 18,600 mg/kg for IHSSs 200, 201, and 202, respectively) and medians (16,400, 14,150, and 18,300 mg/kg for IHSSs 200, 201, and 202, respectively) for the three reservoirs are similar.

#### **G.4.9 Lead**

In each of the three reservoirs, only one population was identified for lead, based on the PROBLOT analysis. The similarity of the means and medians for the three reservoirs indicates that the background mean and median for lead is between 20 and 30 mg/kg, a narrow range considering the diverse source areas for the three reservoirs.

The maximum concentration of lead occurs in Standley Lake. The Standley Lake maximum is approximately twice the maximum concentration for Great Western Reservoir and six times the maximum in Mower Reservoir. Although Mower Reservoir receives 100 percent of its water

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from the RFP drainage, Mower Reservoir sediments have approximately half the lead concentration of Great Western Reservoir sediments and only 20 percent of the Standley Lake maximum sediment concentration. The likely source area for the lead in Standley Lake sediments is from the mining wastes being transported in Clear Creek. Only one sample (SED012792) from the 41 Great Western Reservoir samples exceeds the 95th percentile concentration (70 mg/kg) of the PROBPLOT-defined background population with a concentration of 80.3 mg/kg. This sample is located in the deepest portion of the reservoir. As described previously, the fine-grained sediments are transported to the deepest portion of the reservoir; this is probably why the concentration is higher. Contamination is not indicated because metals adsorb more readily to the finer-grained material (Davis and Kent, 1990, and Pankow, 1991).

#### G.4.10 Lithium

Based on probability plots, there is one population for lithium in all three reservoirs. Mean and median concentrations are highest in Mower, intermediate in Great Western, and lowest in Standley Lake. In all three, the median is higher than the mean lithium concentration; this indicates a dominance of lower lithium concentrations in all three populations. Similar to other metals, the maximum lithium concentration is highest in Standley Lake sediments. The maximum concentrations of lithium for Standley Lake, Great Western Reservoir, and Mower Reservoir are 34.6, 17.6 and 16.2 mg/kg, respectively. Lithium is a common constituent in micas, which are released by acid attack (mine waste areas) and, to a much lesser extent, natural weathering processes; ultimately, they are incorporated in the clay minerals (Deer et al., 1971). The maximum concentration occurring in Standley Lake is likely due to the contribution from the highly mineralized sediments from Clear Creek.

#### G.4.11 Manganese

One population for manganese was identified in Great Western Reservoir and Standley Lake from PROBPLOT for manganese. In Mower Reservoir, two similar populations were identified. The mean and medians for Great Western Reservoir (378.6 and 441.4 mg/kg, respectively) and Standley Lake (449.7 and 350.8 mg/kg, respectively) sediments are similar, but the maximum

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manganese concentration in Standley Lake (4450.4 mg/kg) sediments is three times higher than the maximum concentration in Great Western Reservoir (1549.9 mg/kg). This probably reflects the contribution from the highly mineralized Clear Creek sediments to Standley Lake. The mean, median, and maximum concentrations of manganese (294, 250.8, and 1170 mg/kg, respectively) are the lowest in Mower Reservoir.

The two subpopulation distributions in Mower Reservoir converge near the upper threshold concentration. The two subpopulations are likely due to fluctuations in pH within the reservoir. Of the three reservoirs, Mower Reservoir is the most strongly influenced by algal growth, which causes a diurnal (and seasonal) increase in pH to values above 9. Manganese precipitates much more rapidly with increasing pH, precipitating in minutes to hours at pH values higher than 8 (Stumm, 1990, and Pankow, 1991). This process increases the amount of oxidized manganese deposited in the reservoir sediments and causes variability in concentrations, depending on when the sampling occurred. In the other two reservoirs, manganese is also oxidized and precipitated, but the algal population is not sufficient to enhance the precipitation process. The two populations in Mower Reservoir are likely due to physical processes. The two subpopulations are similar to Standley Lake and Great Western Reservoir.

#### G.4.12 Mercury

Probability plots were only developed for Standley Lake. There was an insufficient number of detects to perform a PROBLOT analysis for Great Western Reservoir and Mower Reservoir. One population was observed in Standley Lake based on the probability plot. The maximum mercury concentration in Standley Lake sediment is only 0.6 mg/kg. Considering the potential strong complexing characteristics (organics, microbiota, and chloride) of mercury and the placering (historical use of elemental mercury to recover gold) that has taken place along Clear Creek, these sediment concentrations of mercury are low.

#### G.4.13 Nickel

Based on the probability plots, one population for nickel was identified for each of the three reservoirs. The mean and median nickel concentrations in both Great Western Reservoir and

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Mower Reservoir are essentially the same values (16 to 17.5 mg/kg) and higher than Standley Lake sediment mean and median. The nickel is slightly higher in Mower Reservoir than in Great Western Reservoir; this difference may be due to the presence of aquatic microbiota.

Only one of the 41 Great Western sediment samples (SED00692) exceeds the 95th percentile concentration from PROBLOT; the sample is located along Broomfield Ditch. This is the same location that has the highest concentrations for cobalt, manganese, and one of the highest concentrations for iron. This is the result of iron/manganese oxyhydroxide adsorption, which elevates the nickel and cobalt concentrations through the adsorption process (Davis and Kent, 1990; Pankow, 1991). This enhancement is most likely a natural phenomenon rather than an anthropogenic impact.

#### G.4.14 Silicon (Silica)

In Great Western Reservoir and Standley Lake, one population for silicon was identified, based on probability plots. In Mower Reservoir, only one sample was analyzed for silicon, so no PROBLOT analysis was performed. The laboratory reports silica ( $\text{SiO}_2$ ) in terms of Silicon, Si. Considering the abundance of silica in quartz and other minerals contained in sediments, the silica concentration is surprisingly low. The maximum concentrations of silica are less than 1 percent (10,000 mg/kg) compared to an average crustal abundance of approximately 28 percent (280,000 mg/kg) (Taylor, 1964). Standley Lake sediments have higher silica concentrations than Great Western, which probably reflects the higher quartz relative to mica in Standley Lake sediments. Quartz is readily available in the placer and mine waste areas of the Clear Creek drainage.

#### G.4.15 Zinc

One population for zinc was identified in each reservoir based on PROBLOT. Zinc is one of the most mobile metals. The zinc mean, median, and maximum concentrations are all highest in Standley Lake (181.9, 184.4, and 1170 mg/kg, respectively) sediments, intermediate in Great Western Reservoir (137.8, 120.5, and 496 mg/kg, respectively), and lowest in Mower Reservoir (69.5, 68.6, and 193 mg/kg, respectively) sediments. These relationships support

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and enforce the relative importance of historic and current mining waste and discharge sources in the Clear Creek drainage to the site-specific background of Standley Lake sediments.

#### G.4.16 $^{239/240}\text{Pu}$

One population for  $^{239/240}\text{Pu}$  was identified for Standley Lake and Great Western Reservoir. Two subpopulations were identified in Mower Reservoir. All activities in both Mower Reservoir and Standley Lake sediments are less than 1 pCi/g. Median activities and 95th percentile activity values from PROBLOT indicate that Standley Lake sediments have the lowest activity, Mower Reservoir has intermediate activities, and Great Western Reservoir has the highest activities in sediments. In fact, three Great Western sediment samples (GWR-EG 46, 47, and 48) have the only activities that exceed 1 pCi/g across all three sediment reservoirs (3.1, 3.2, and 3.3 pCi/g, respectively). These three samples were collected in 1983 investigations. Given the two subpopulations in Mower Reservoir are similar to the values to the single populations in the other two IHSSs, it appears the activities represent background conditions. Further, the two subpopulations are converging, which indicates natural processes affecting one natural-background population.

#### G.4.17 $^{233/234}\text{U}$

Based on PROBLOT,  $^{233/234}\text{U}$  is remarkably consistent in all three reservoirs and shows only one population. The median activities for all three reservoirs are similar, ranging from 1.20 to 1.24 pCi/g. The 95th percentile activity values for Great Western and Mower are similar (2.79 and 2.61 pCi/g, respectively) but lower than Standley Lake sediment (3.71 pCi/g). The highest activity is in Great Western Reservoir (SED06692).

#### G.4.18 $^{235}\text{U}$

Based on the PROBLOT analysis, one population for  $^{235}\text{U}$  was identified in each of the reservoirs. With the exception of a single exceedance from a sample in Great Western Reservoir (SED06692), described in the  $^{233/234}\text{U}$  discussion, the  $^{235}\text{U}$  activities are a background population. This single population is indicated by means, medians, and PROBLOT

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95th percentile activities. The suite of radioactivity present at SED06692 is likely due to natural uranium mineralization and not anthropogenic contamination.

#### G.4.19 Summary for Sediments

Most of the metals and radionuclides reviewed indicate the presence of only one population in a given reservoir. Where two subpopulations were identified, a review of the natural physical processes and associated physicochemical conditions indicates that the differences are due to natural environmental variability and not to contamination. As shown in Figure G-2, these chemicals exhibit two converging populations, unlike the diverging populations of the  $^{239/240}\text{Pu}$  surface soil data.

#### G.5 DATA INTERPRETATION FOR SURFACE WATER

Surface water parameters selected for this evaluation include arsenic, lead, manganese, silicon, and iron for the three reservoirs and for background stream samples collected for the Background Geochemical Characterization Report (DOE, 1993). The data for OU 3 and the background stream data were combined for the PROBPLOT analysis because some of the metals had a low frequency detection and there would not be sufficient sample sizes to perform PROBPLOT on an IHSS-by-IHSS basis. The number of samples with detected concentrations show considerable variability. Arsenic has only 33 detections; lead, 103; silica, 118; manganese, 208; and iron, 218.

Streams, particularly turbulent streams, have a relatively high total dissolved oxygen that imparts a high oxidation-reduction potential or Eh to the water. A high Eh and near-neutral pH in surface water results in the precipitation of iron oxyhydroxide, reducing the dissolved iron to approximately 0.1 milligram per liter or less. In the case of Clear Creek, iron is transported as a colloidal flocculent from the mineralization in the headwaters. This flocculent typically adsorbs metals (arsenic, copper, lead, etc.) (Davis and Kent, 1990; Pankow, 1991). The Clear Creek water is a major source of surface water into Standley Lake and also contributes to Great Western Reservoir but not to Mower Reservoir.

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The PROBLOT analyses for surface water show only one population for each of the metals evaluated. The PROBLOT results for each metal are described in the following paragraphs.

#### G.5.1 Arsenic

Based on PROBLOT, one population has been identified in arsenic for the surface-water data. The mean, median, and maximum concentrations of arsenic are 2.54, 2.52, 6.6  $\mu\text{g/L}$ , respectively. The similar mean and median concentrations indicate that the population is a statistically normal background population. The 95th percentile cumulative frequency analysis concentration and the geometric mean plus two standard deviations concentration is 9.16  $\mu\text{g/L}$ . This indicates that not only is the arsenic a normal distribution but also that the highest arsenic concentration is less than this value.

#### G.5.2 Iron

Based on the probability plot, one population for iron was identified in the combined OU 3 and background data set for iron. The mean iron concentration is lower than the median, indicating that more samples have concentrations lower than the mean concentration. However, the maximum concentration (26.3 mg/L) and four other background samples are above the 95th percentile iron concentration, which the cumulative frequency distribution indicates to be a single population. In fact, the highest 18 surface-water samples are background samples.

The highest iron concentration for a OU 3 surface-water sample is from Great Western Reservoir (SW00692) with a iron concentration of only 2.34 mg/L (less than half the Background Geochemical Characterization Report samples). Therefore, all three reservoirs included in the OU 3 area are well within the statistically defined background population.

#### G.5.3 Lead

Based on probability plots, one population for lead is identified in the surface-water data. The mean lead concentration is slightly higher than the median (3.6 versus 3.4  $\mu\text{g/L}$ ), indicating the potential for a slight skewness toward concentrations above the mean rather than below the

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mean in the 103 samples. The cumulative frequency distribution defines a 95th percentile concentration of 14.8  $\mu\text{g/L}$  compared with a maximum concentration of 37.2  $\mu\text{g/L}$  for lead. There are only four samples (about 4 percent of the total detected population) with a lead concentration greater than 14.8  $\mu\text{g/L}$ : two are from Mower (SW02792 and SW3092), one is from Great Western (SW02192), and one is from the background data (SW130). The distribution of these four samples is only slightly above and paralleling the normal distribution line for the total population, indicating adsorption processes rather than a contaminant source.

The two Mower Reservoir samples correspond with detected arsenic samples. This strongly suggests that both are present and accumulated as adsorbed phases on iron oxyhydroxide. Both are among the most strongly adsorbed of ions on this adsorption medium. Similar to the adsorbed arsenic, the lead adsorbed to the iron oxyhydroxides will have a tendency to be retained in the reservoir water. Unlike arsenic, lead can be also be precipitated as a relatively insoluble lead carbonate mineral and be incorporated into the bottom sediments (Pankow, 1991). The fact that one of the 95 percent exceedances is from the background data indicates that elevated concentrations of lead in Great Western Reservoir and Mower Reservoir are not unique. The Great Western sample is lower than background sample (17 versus 18.5  $\mu\text{g/L}$ ).

#### G.5.4 Manganese

The probability plot for manganese indicates one population is present for the surface-water data set. The mean manganese concentration is slightly higher than the median (33.5 versus 32.4  $\mu\text{g/L}$ ), indicating the potential for a slight tendency for samples to occur above the mean rather than below the mean. The maximum concentration (4,060  $\mu\text{g/L}$ ) is much higher than the 95th percentile concentration (444  $\mu\text{g/L}$ ) defined by the cumulative frequency analysis. However, only four of the 208 detected manganese concentrations (approximately 2 percent of the total detected population) exceeded the 95th percentile concentration.

The maximum value and third highest concentration of manganese are background samples (SW107 and SW041, respectively). The location of maximum manganese concentration is also the location of maximum iron concentration. This strongly suggests that at least these two samples, and potentially all four, are associated with iron oxyhydroxide precipitates. The

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remaining two samples are from Standley Lake, which receives surface water from Clear Creek. Dissolved manganese is released from the mineralization and mine wastes in the upper part of Clear Creek.

#### G.5.5 Silicon

Based on the probability plot for silicon, one population was identified. All of the 118 detected silicon concentrations are within the 95th percentile *silicon concentration*, defined by the cumulative frequency distribution. The mean silicon concentration (435  $\mu\text{g/L}$ ) is less than the median (474  $\mu\text{g/L}$ ), suggesting more silicon concentrations are lower than the mean than higher than the mean. The maximum silicon concentration is 3.4 mg/L, which is lower than the 95th percentile concentration of 18.6 mg/L. Therefore, this suite of silicon concentrations form a statistically normal population of which there are no concentrations from the three reservoirs or background samples that exceed the 95th percentile concentration.

#### G.5.6 Summary for Surface Water

The PROBPLOT analysis for surface water indicates that, for the metals reviewed, only one population is present when all the reservoir and background data are combined. No statistical difference, based on the cumulative frequency distribution, was identified between the background samples collected as part of the Background Geochemical Characterization Report (DOE, 1993) and the OU 3 surface-water data.

### G.6 PROBPLOT OUTPUT

PROBPLOT output is provided for each metal and radionuclide evaluated. The plots are presented alphabetically by IHSS (200, 201, and 202) with sediments first, followed by surface water. The first page for a given chemical and IHSS is the summary statistics and histogram, followed by the probability plot. The last page is a summary of the parameters used in performing the probability plot analysis (data file name, variable input, number of samples, and number of populations present).

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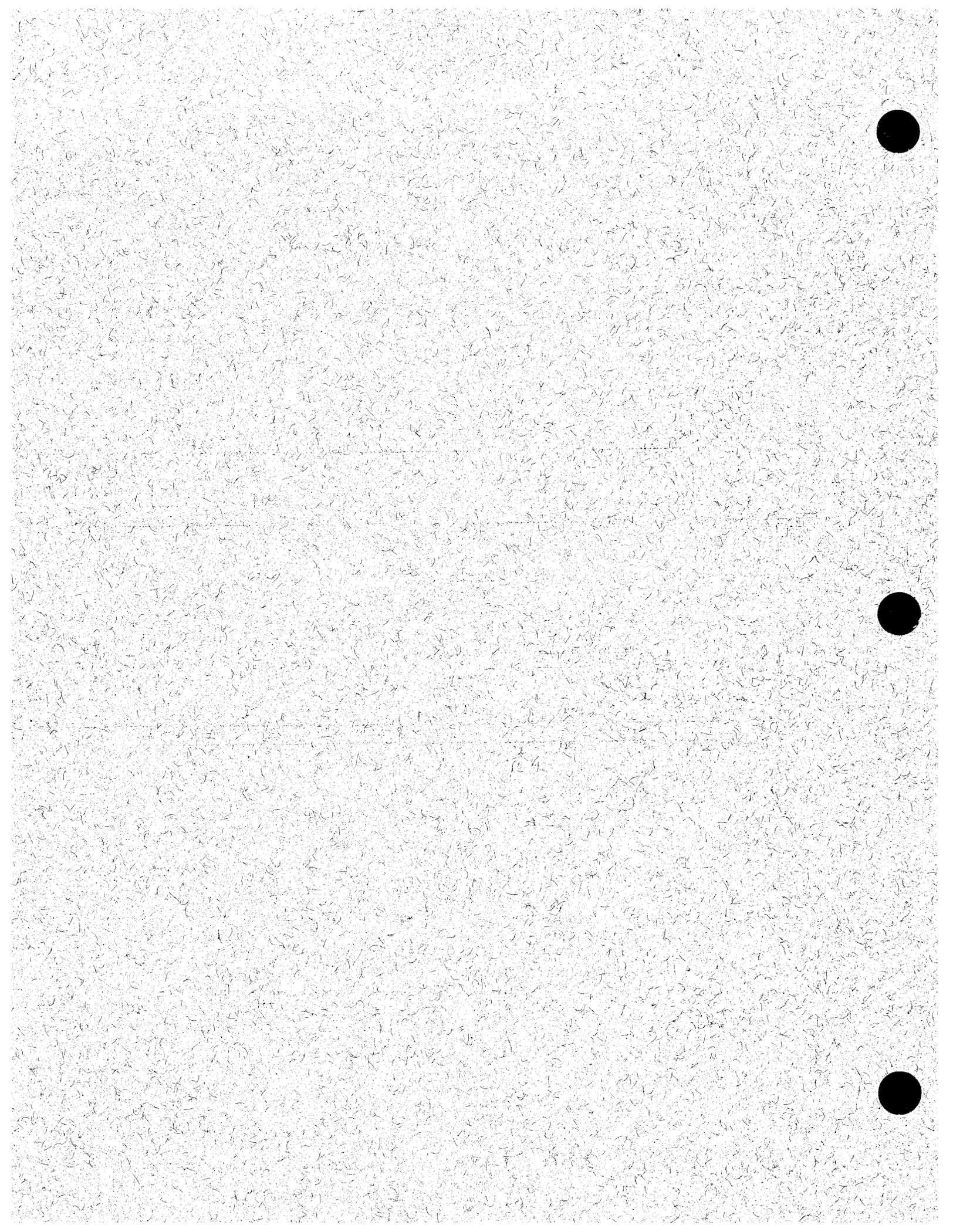
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**ALUMINUM**

**IHSS 200, Great Western Reservoir**



20:28:37

RFP / DU-3

05/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Al Unit = MG/K N = 41

Mean = 3.9779 Min = 3.3464 1st Quartile = 3.8737  
 Std. Dev. = 0.1989 Max = 4.3181 Median = 3.9936  
 CV % = 5.0008 Skewness = -0.7455 3rd Quartile = 4.1222

Anti-Log Mean = 9504.265 Anti-Log Std. Dev. : (-) 6011.595  
 (+)15026.138

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0607)
0.00	1.19	2070.080	3.3160	
2.44	3.57	2380.778	3.3767	*
0.00	3.57	2738.110	3.4375	
0.00	3.57	3149.073	3.4982	
0.00	3.57	3621.718	3.5589	
0.00	3.57	4165.302	3.6196	
4.88	8.33	4790.473	3.6804	**
4.88	13.10	5509.476	3.7411	**
4.88	17.86	6336.394	3.8018	**
4.88	22.62	7287.425	3.8626	**
12.20	34.52	8381.196	3.9233	*****
12.20	46.43	9639.131	3.9840	*****
9.76	55.95	11085.870	4.0448	****
12.20	67.86	12749.751	4.1055	*****
14.63	82.14	14663.363	4.1662	*****
9.76	91.67	16864.190	4.2270	****
2.44	94.05	19395.340	4.2877	*
4.88	98.81	22306.390	4.3484	**

0 1 2 3 4

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20:29:11

05/08/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = RI

UNIT = MG/K

N = 41

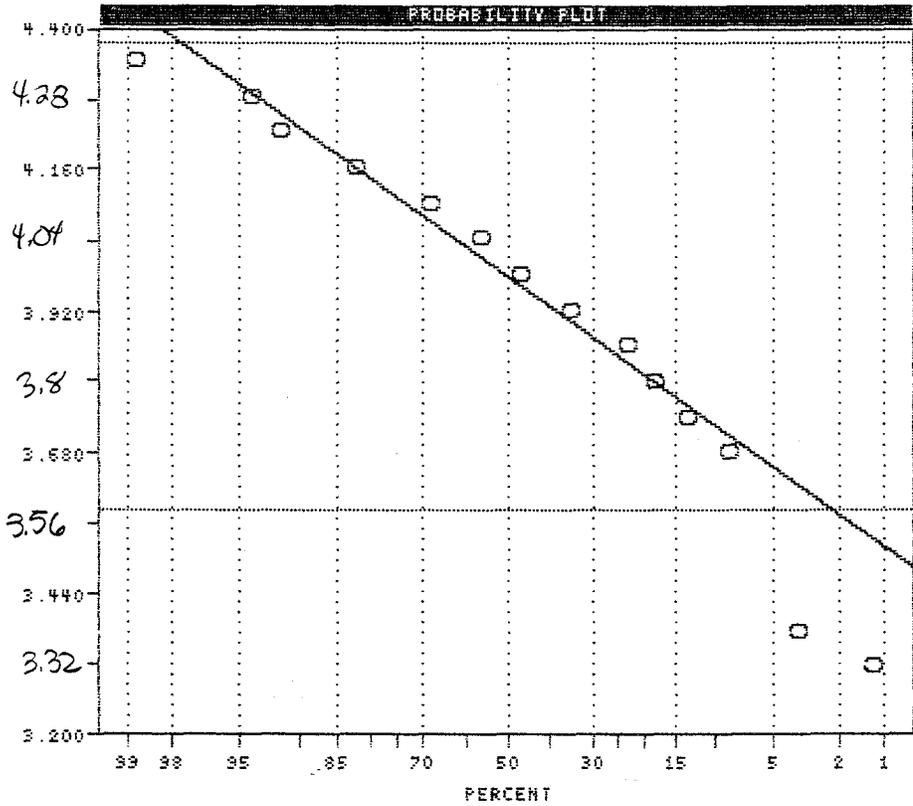
R CI = 17

POPULATIONS

=====

Pop.	Mean	Std.Dev.	n
1	3.9779	0.1389	100.0

Pop.	THRESHOLDS	
1	3.5801	4.3758



RAW DATA NL  
PARAMETER ESTIMATES

20:30:12

RFP / OU-3

05/08/94

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PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = AL-OD.DAT

Variable = Al Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

\*\*\*\*\*

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 8.531

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	9504.265	- 6011.595 + 15026.138	100.00

\*\*\*\*\*



15:20:49  
05/10/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = A1  
UNIT = MG/K  
N = 47  
N CI = 17

POPULATIONS

Pop.	Mean	Std.Dev.	%
1	3.8228	0.3747	100.0

Pop. THRESHOLDS

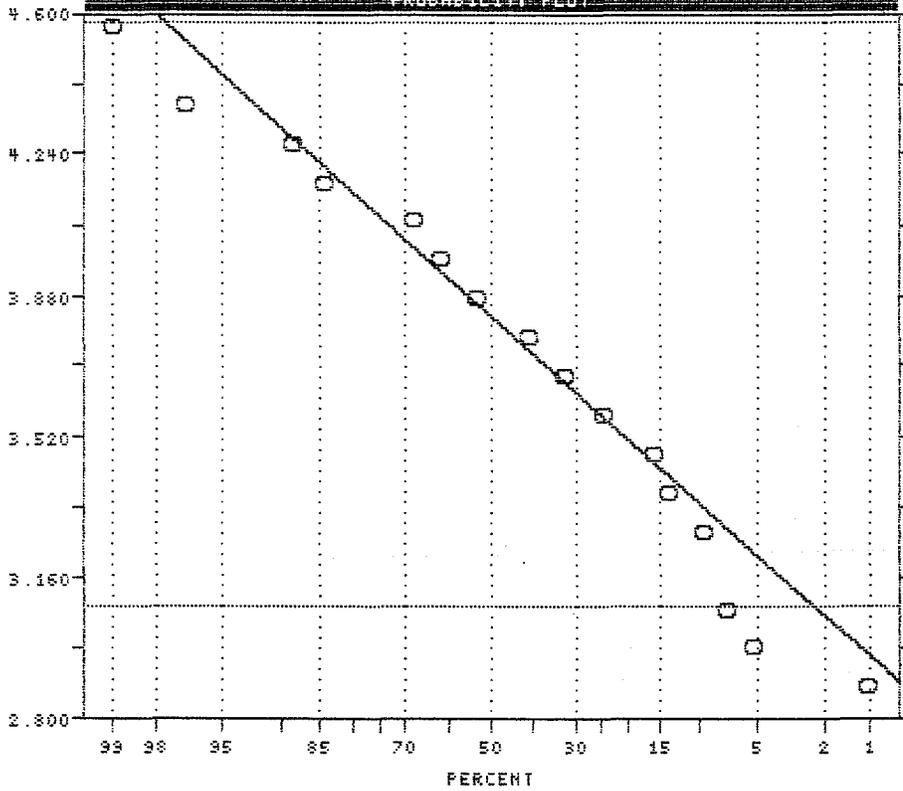
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1	3.0804	4.5732
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RAW DATA HL

PARAMETER ESTIMATES

PROBABILITY PLOT



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PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = AL-1D.DAT

Variable = A1 Unit = MG/K N = 47  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -20.056

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	6757.913	- 2851.644 + 16015.112	100.00

#####

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = A1 Unit = MB/K N = 19

Mean = 4.1240 Min = 3.8739 1st Quartile = 4.0063  
 Std. Dev. = 0.1128 Max = 4.2625 Median = 4.1642  
 CV % = 2.7362 Skewness = -0.7386 3rd Quartile = 4.2108

Anti-Log Mean = 13305.038 Anti-Log Std. Dev. : (-)10260.612  
 (+)17252.776

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=====
```

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0324)
0.00	2.50	7206.295	3.8577	
5.26	7.50	7764.101	3.8901	*
0.00	7.50	8365.084	3.9225	
0.00	7.50	9012.586	3.9548	
10.53	17.50	9710.208	3.9872	**
5.26	22.50	10461.830	4.0196	*
5.26	27.50	11271.631	4.0520	*
5.26	32.50	12144.116	4.0844	*
5.26	37.50	13084.135	4.1167	*
5.26	42.50	14096.917	4.1491	*
15.79	57.50	15188.094	4.1815	***
21.05	77.50	16363.734	4.2139	****
10.53	87.50	17630.374	4.2463	**
10.53	97.50	18995.059	4.2786	**

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0 1 2 3 4

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13:49:14

06/24/94

RFP / DU-3: A1-S

LOGARITHMIC VALUES

=====

VARIABLE = A1

UNIT = MG/K

N = 19

N CI = 13

POPULATIONS

=====

Pop.	Mean	Std. Dev.	%
1	4.0285	0.0967	46.5
2	4.2040	0.0308	53.5

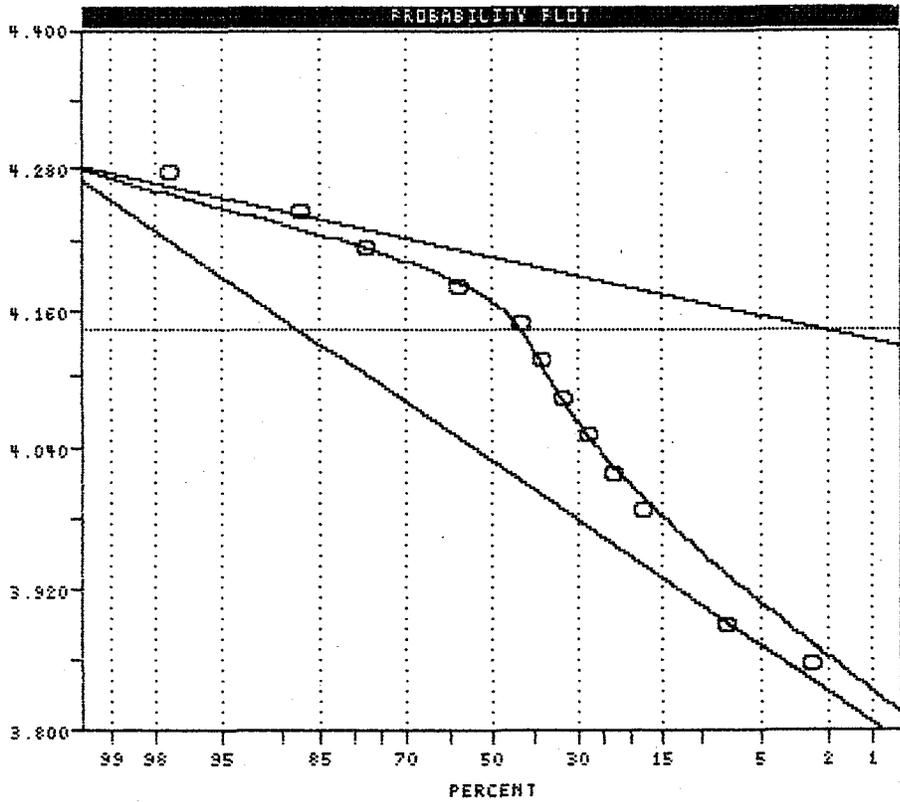
THRESHOLDS

=====

4.1426

RAW DATA ML

PARAMETER ESTIMATES



#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:AL-S.DAT

Variable = A1 Unit = MG/K N = 19  
N CI = 13

Transform = Logarithmic Number of Populations = 2

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 19.179

Parameterized Degrees of Freedom = 3

Population	Mean	Std Dev	Percentage
1	10678.966	- 8548.046 + 13341.097	46.52
2	15994.344	- 14898.478 + 17170.816	53.48

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Thresholds Which Minimize Classification Errors.

Thresholds  
  
13887.804

#####

20:21:38

RFP / OU-3

05/08/94

\*\*\*\*\*  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	As	Unit =	MG/K	N =	41
Mean =	0.6749	Min =	0.4150	1st Quartile =	0.5682
Std. Dev. =	0.1208	Max =	0.9731	Median =	0.6628
CV % =	17.8955	Skewness =	0.2745	3rd Quartile =	0.7442
Anti-Log Mean =	4.731	Anti-Log Std. Dev. :	(-)	3.582	
			(+)	6.247	

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0349)
0.00	1.19	2.498	0.3975	
2.44	3.57	2.707	0.4324	*
0.00	3.57	2.933	0.4673	
2.44	5.95	3.178	0.5022	*
4.88	10.71	3.444	0.5371	**
17.07	27.38	3.732	0.5720	*****
2.44	29.76	4.044	0.6068	*
7.32	36.90	4.383	0.6417	***
19.51	55.95	4.749	0.6766	*****
4.88	60.71	5.146	0.7115	**
12.20	72.62	5.577	0.7464	*****
7.32	79.76	6.043	0.7813	***
7.32	86.90	6.549	0.8161	***
4.88	91.67	7.096	0.8510	**
2.44	94.05	7.690	0.8859	*
0.00	94.05	8.333	0.9208	
2.44	96.43	9.030	0.9557	*
2.44	98.81	9.785	0.9906	*

0 1 2 3 4

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20:22:07  
05/08/94

RFP / DU-3

LOGARITHMIC VALUES

=====

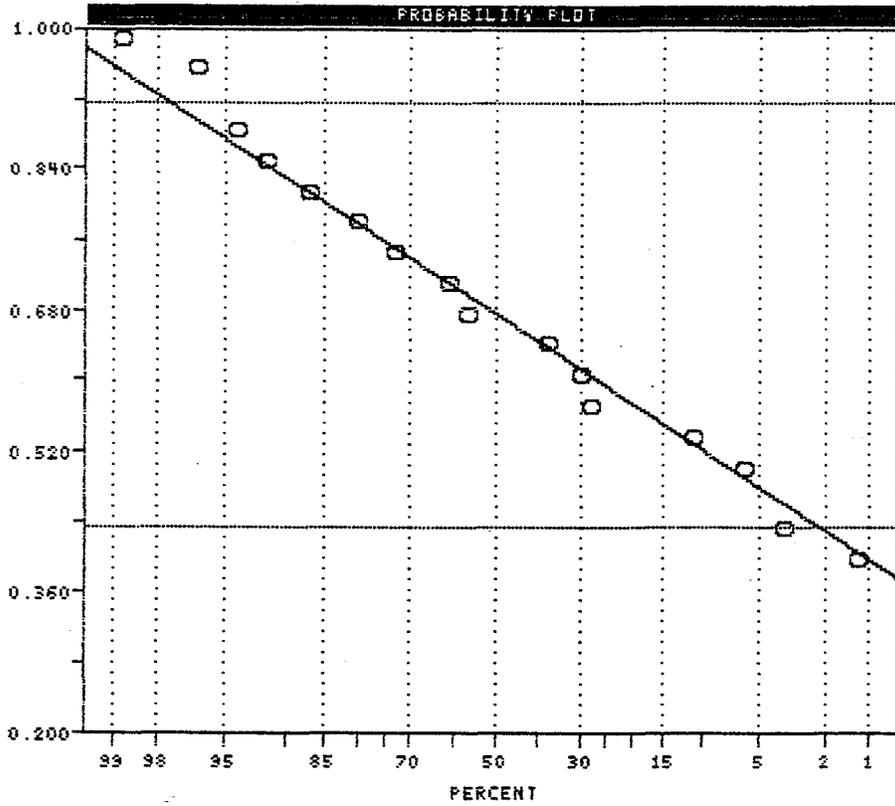
VARIABLE = As  
UNIT = MG/K  
N = 41  
N CI = 17

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.6749	0.1208	100.0

Pop.	THRESHOLDS	
1	0.4334	0.9165



RAW DATA ML  
PARAMETER ESTIMATES

20:23:14

RFP / OU-3

05/08/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = AS-OD.DAT

Variable = As Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 28.989

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	4.731	- 3.582 + 6.247	100.00

#####

15:08:03

RFP / OU-3

05/10/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable =	As	Unit =	MG/K	N =	47
Mean =	0.6962	Min =	0.0792	1st Quartile =	0.4191
Std. Dev. =	0.2963	Max =	1.2253	Median =	0.7201
CV % =	42.5597	Skewness =	-0.3356	3rd Quartile =	0.9457
Anti-Log Mean =	4.968	Anti-Log Std. Dev. =	(-) 2.511	(+)	9.828

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0716)
0.00	1.04	1.105	0.0434	
2.13	3.13	1.303	0.1150	*
4.26	7.29	1.537	0.1866	**
4.26	11.46	1.812	0.2583	**
4.26	15.63	2.137	0.3299	**
4.26	19.79	2.521	0.4015	**
6.38	26.04	2.973	0.4732	***
2.13	28.13	3.506	0.5448	*
4.26	32.29	4.135	0.6164	**
14.89	46.88	4.876	0.6881	*****
14.89	61.46	5.750	0.7597	*****
0.00	61.46	6.782	0.8313	
8.51	69.79	7.998	0.9030	****
10.64	80.21	9.432	0.9746	*****
4.26	84.37	11.123	1.0462	**
12.77	96.87	13.118	1.1179	*****
0.00	96.87	15.470	1.1895	
2.13	98.96	18.244	1.2611	*

0                    1                    2                    3                    4

#####

15:08:39  
05/10/94

RFP / DU-3

LOGRITHMIC VALUES

=====

VARIABLE = As  
UNIT = HG/K  
N = 47  
N CI = 17

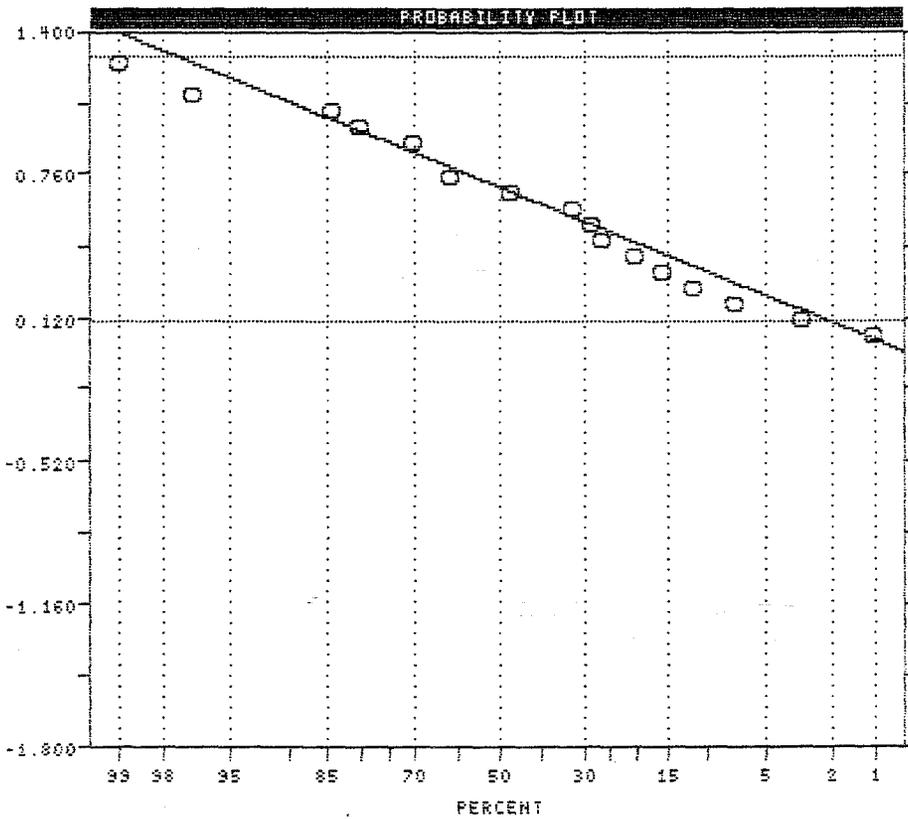
POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.6962	0.2363	100.0

Pop. THRESHOLDS

Pop.	Lower	Upper
1	0.1036	1.2887



RAW DATA HL  
PARAMETER ESTIMATES

15:11:37

RFP / OU-3

05/10/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = AS-1D.DAT

Variable = As Unit = MG/K N = 47  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -9.018

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	4.968	- 2.511 + 9.828	100.00

\*\*\*\*\*

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUE

Variable = As Unit = MG/K N = 18

Mean = 0.6793 Min = 0.3424 1st Quartile = 0.5623  
 Std. Dev. = 0.1619 Max = 1.0170 Median = 0.7076  
 CV % = 23.8314 Skewness = -0.2023 3rd Quartile = 0.7443

Anti-Log Mean = 4.778 Anti-Log Std. Dev. : (-) 3.292  
 (+) 6.937

```
=====
```

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0562
0.00	2.63	2.062	0.3143	
5.56	7.89	2.347	0.3705	*
0.00	7.89	2.671	0.4267	
11.11	18.42	3.041	0.4830	**
0.00	18.42	3.461	0.5392	
11.11	28.95	3.939	0.5954	**
5.56	34.21	4.484	0.6516	*
22.22	55.26	5.103	0.7078	****
22.22	76.32	5.808	0.7641	****
5.56	81.58	6.611	0.8203	*
11.11	92.11	7.525	0.8765	**
0.00	92.11	8.565	0.9327	
0.00	92.11	9.748	0.9889	
5.56	97.37	11.095	1.0451	*

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-----
```

0                    1                    2                    3

#####

11:11:52  
05/03/94

RFP / DU-3: As-S

LOGARITHMIC VALUES

=====

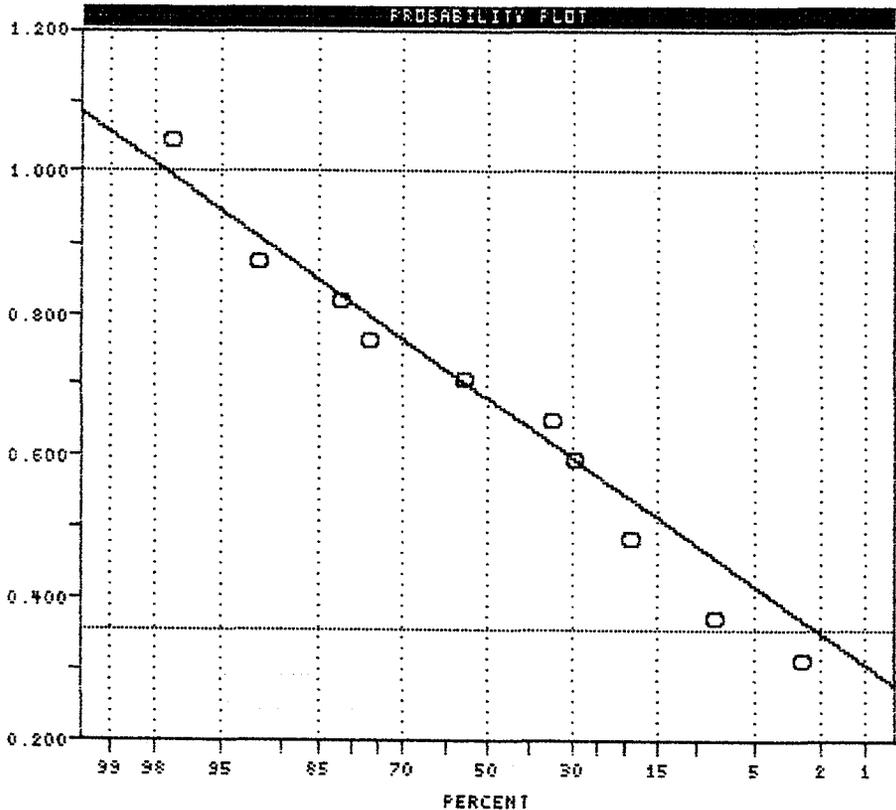
VARIABLE = As  
UNIT = MG/K  
N = 18  
N CI = 13

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.6798	0.1619	100.0

Pop.	THRESHOLDS
1	0.3555 1.0030



RAW DATA ML  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:AS-S.DAT

Variable = As Unit = MG/K N = 18  
N CI = 13

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 7.735

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	4.778	- 3.292 + 6.937	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	2.267 10.070

#####

19:13:26

RFP / OU-3

05/08/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Be Unit = MG/K N = 41

Mean = -0.1044 Min = -0.6198 1st Quartile = -0.1973  
Std. Dev. = 0.1636 Max = 0.2041 Median = -0.0784  
CV % = 156.7277 Skewness = -0.8475 3rd Quartile = 0.0000

Anti-Log Mean = 0.786 Anti-Log Std. Dev. : (-) 0.540  
(+) 1.146

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0515)
0.00	1.19	0.226	-0.6455	
2.44	3.57	0.255	-0.5940	*
0.00	3.57	0.287	-0.5425	
0.00	3.57	0.323	-0.4911	
0.00	3.57	0.363	-0.4396	
2.44	5.95	0.409	-0.3881	*
7.32	13.10	0.461	-0.3366	***
2.44	15.48	0.519	-0.2851	*
4.88	20.24	0.584	-0.2336	**
7.32	27.38	0.658	-0.1821	***
12.20	39.29	0.740	-0.1306	*****
9.76	48.81	0.833	-0.0791	****
9.76	58.33	0.938	-0.0276	****
26.83	84.52	1.057	0.0239	*****
2.44	86.90	1.190	0.0754	*
7.32	94.05	1.339	0.1269	***
2.44	96.43	1.508	0.1784	*
2.44	98.81	1.698	0.2299	*

0 1 2 3 4

#####

19:18:55  
05/08/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Be  
UNIT = HG/K  
N = 41  
N CI = 17

POPULATIONS

=====

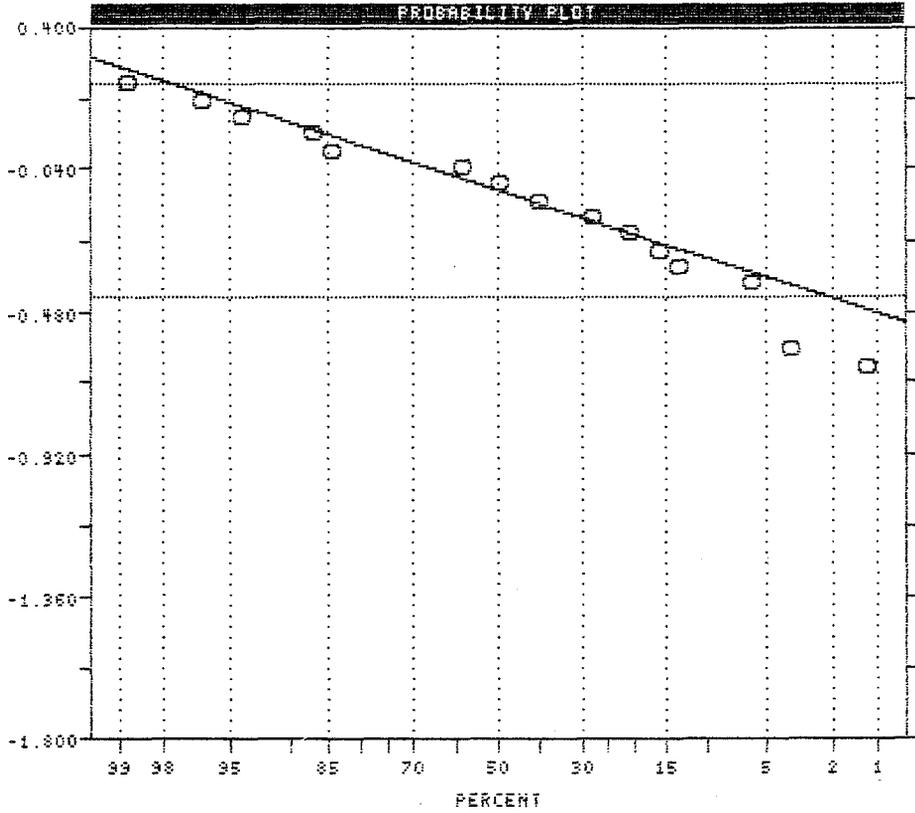
Pop.	Mean	Std.Dev.	%
1	-0.1044	0.1636	100.0

POP. THRESHOLDS

Pop.	Mean	Std.Dev.
1	-0.4316	0.2228

RAW DATA ML

PARAMETER ESTIMATES



\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = BE-03.DAT

Variable = Be Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 16.550

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.786	- 0.540 + 1.146	100.00

\*\*\*\*\*

14:13:03

RFP / DU-3

05/10/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
#####

Variable =	Be	Unit =	MG/K	N =	43
Mean =	-0.2271	Min =	-0.8239	1st Quartile =	-0.4593
Std. Dev. =	0.2637	Max =	0.2041	Median =	-0.2244
CV % =	116.1341	Skewness =	-0.2077	3rd Quartile =	-0.0114
Anti-Log Mean =	0.593	Anti-Log Std. Dev. :	(-) 0.323	(+)	1.088

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0643)
0.00	1.14	0.139	-0.8560	
2.33	3.41	0.162	-0.7918	*
2.33	5.68	0.187	-0.7275	*
0.00	5.68	0.217	-0.6633	
4.65	10.23	0.252	-0.5990	**
2.33	12.50	0.292	-0.5348	*
9.30	21.59	0.338	-0.4705	****
4.65	26.14	0.392	-0.4063	**
11.63	37.50	0.455	-0.3420	*****
2.33	39.77	0.528	-0.2778	*
9.30	48.86	0.612	-0.2135	****
11.63	60.23	0.709	-0.1493	*****
6.98	67.05	0.822	-0.0850	***
6.98	73.86	0.953	-0.0208	***
11.63	85.23	1.105	0.0435	*****
0.00	85.23	1.262	0.1077	
6.98	92.05	1.486	0.1720	***
6.98	98.86	1.723	0.2362	***

0                    1                    2                    3                    4

#####

14:14:22  
05/10/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Be  
UNIT = HG/K  
N = 43  
N CI = 17

POPULATIONS

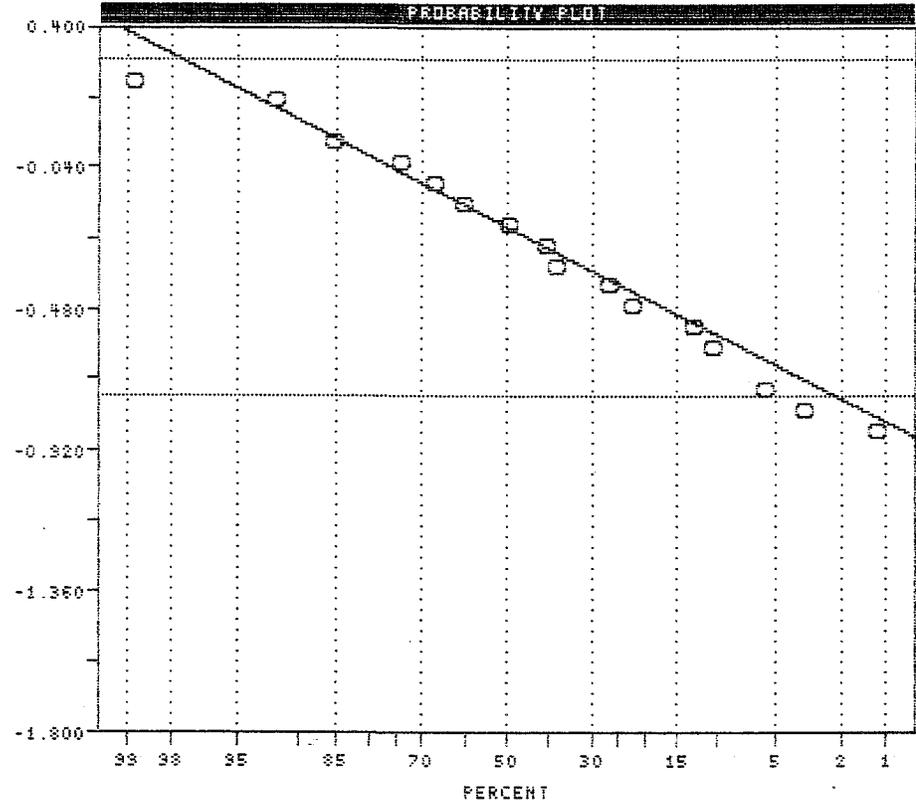
=====

Pop.	Mean	Std.Dev.	%
1	-0.2271	0.2637	100.0

Pop. THRESHOLDS

-----  
=====

1	-0.7545	0.3004
---	---------	--------



RAW DATA ML  
PARAMETER ESTIMATES

14:15:31

RFP / OU-3

05/10/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = BE-1D.DAT

Variable = Be Unit = MG/K N = 43  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -3.205

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.593	- 0.323 + 1.088	100.00

#####

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Be Unit = MG/K N = 16

Mean = -0.0217 Min = -0.3872 1st Quartile = -0.0862  
 Std. Dev. = 0.1683 Max = 0.1761 Median = 0.0414  
 CV % = 773.9253 Skewness = -0.7923 3rd Quartile = 0.1139

Anti-Log Mean = 0.951 Anti-Log Std. Dev. : (-) 0.646  
 (+) 1.401

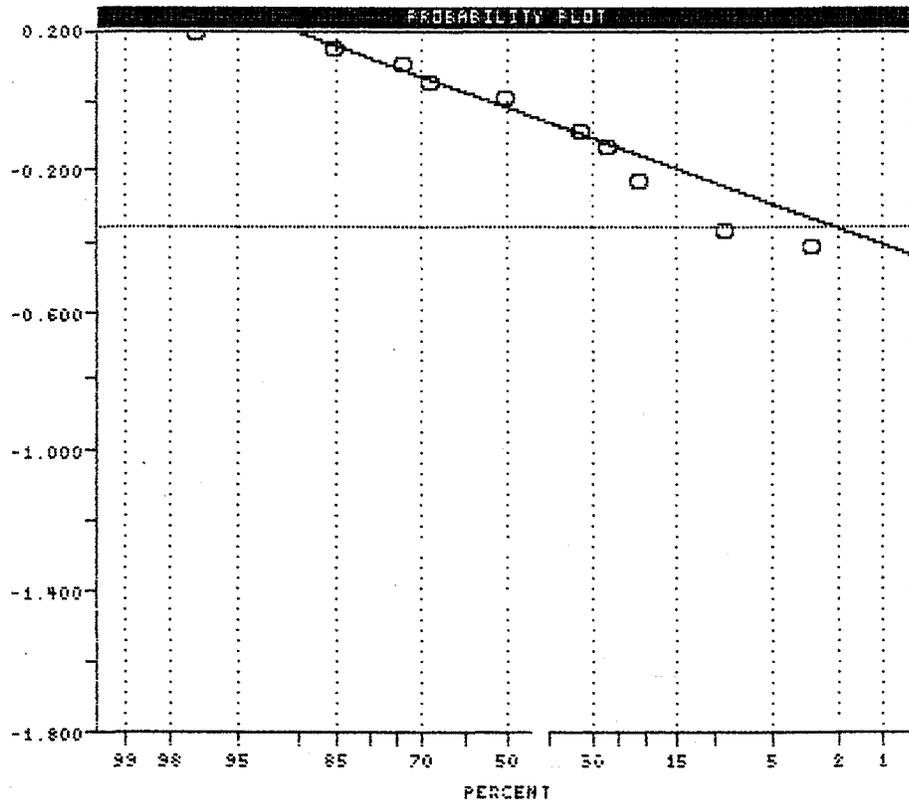
=====				
%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0469)
-----				
0.00	2.94	0.388	-0.4107	
6.25	8.82	0.433	-0.3637	*
0.00	8.82	0.482	-0.3168	
0.00	8.82	0.537	-0.2699	
12.50	20.59	0.599	-0.2229	**
0.00	20.59	0.667	-0.1760	
6.25	26.47	0.743	-0.1290	*
6.25	32.35	0.828	-0.0821	*
0.00	32.35	0.922	-0.0351	
18.75	50.00	1.028	0.0118	***
18.75	67.65	1.145	0.0587	***
6.25	73.53	1.275	0.1057	*
12.50	85.29	1.421	0.1526	**
12.50	97.06	1.583	0.1996	**
-----				
			0	1
				2
				3
				4

#####

13:46:10  
06/24/84

RFP / DU-3: Be-S

LOGARITHMIC VALUES



VARIABLE = Be  
UNIT = MG/K  
N = 16  
N CI = 13

POPULATIONS

Pop.	Mean	Std.Dev.	%
1	-0.0217	0.1683	100.0

THRESHOLDS

1	-0.3583	0.3148
---	---------	--------

RAW DATA ML  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:BE-S.DAT

Variable = Be Unit = MG/K N = 16  
N CI = 13

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 6.311

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.951	- 0.646 + 1.401	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	0.438 - 2.065

#####

18:52:54

RFP / OU-3

05/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable =	Cd	Unit =	MG/K	N =	16
Mean =	-0.0211	Min =	-0.3872	1st Quartile =	-0.1549
Std. Dev. =	0.1780	Max =	-0.2041	Median =	0.0792
CV % =	844.2943	Skewness =	-0.4949	3rd Quartile =	0.1461
Anti-Log Mean =	0.953	Anti-Log Std. Dev. :	(-) 0.632	(+) 1.435	

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0493)
0.00	2.94	0.387	-0.4119	
6.25	8.82	0.434	-0.3626	*
0.00	8.82	0.486	-0.3133	
0.00	8.82	0.544	-0.2640	
6.25	14.71	0.610	-0.2147	*
12.50	26.47	0.683	-0.1655	**
12.50	38.24	0.765	-0.1162	**
6.25	44.12	0.857	-0.0669	*
0.00	44.12	0.960	-0.0176	
0.00	44.12	1.076	0.0316	
18.75	61.76	1.205	0.0809	***
12.50	73.53	1.350	0.1302	**
18.75	91.18	1.512	0.1795	***
6.25	97.06	1.693	0.2288	*

0                    1                    2                    3                    4

#####

18:55:01  
05/08/94

RFP / QU-3

LOGARITHMIC VALUES

=====

VARIABLE = Cd  
UNIT = MG/K  
N = 16  
N CI = 13

POPULATIONS

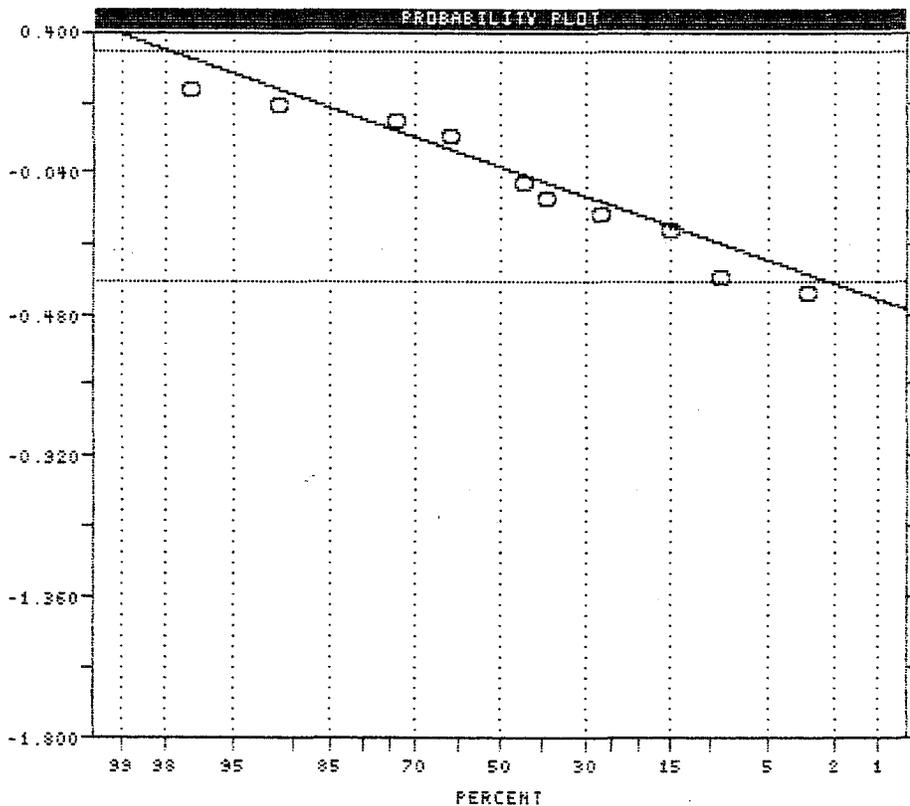
=====

Pop.	Mean	Std.Dev.	%
1	-0.0211	0.1780	100.0

POP. THRESHOLDS

Pop.	Lower	Upper
1	-0.3771	0.3350

RAW DATA HL  
PARAMETER ESTIMATES



18:56:16

RFP / OU-3

05/08/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = CD-OD.DAT

Variable = Cd Unit = MG/K N = 16  
N CI = 13

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 5.410

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.953	- 0.632 + 1.435	100.00

#####

14:03:59

RFP / OU-3

05/10/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable =	Cd	Unit =	MG/K	N =	23
Mean =	0.3918	Min =	-0.2676	1st Quartile =	0.2553
Std. Dev. =	0.2722	Max =	0.7993	Median =	0.4340
CV % =	69.4676	Skewness =	-1.0384	3rd Quartile =	0.6003
Anti-Log Mean =	2.465	Anti-Log Std. Dev. :	(-)	1.317	
			(+)	4.613	

%	cum %	antilog	cls int	(# of bins = 14 - bin size = 0.0821)
0.00	2.08	0.491	-0.3086	
4.35	6.25	0.594	-0.2266	*
4.35	10.42	0.717	-0.1445	*
4.35	14.58	0.866	-0.0624	*
0.00	14.58	1.046	0.0196	
0.00	14.58	1.264	0.1017	
0.00	14.58	1.527	0.1838	
13.04	27.08	1.844	0.2659	***
0.00	27.08	2.228	0.3479	
17.39	43.75	2.692	0.4300	****
26.09	68.75	3.252	0.5121	*****
4.35	72.92	3.928	0.5942	*
17.39	89.58	4.745	0.6762	****
4.35	93.75	5.732	0.7583	*
4.35	97.92	6.924	0.8404	*

0                      1                      2                      3                      4

#####

14:04:36  
05/10/94

RFF / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Cd  
UNIT = HG/K  
N = 23  
N CI = 14

POPULATIONS

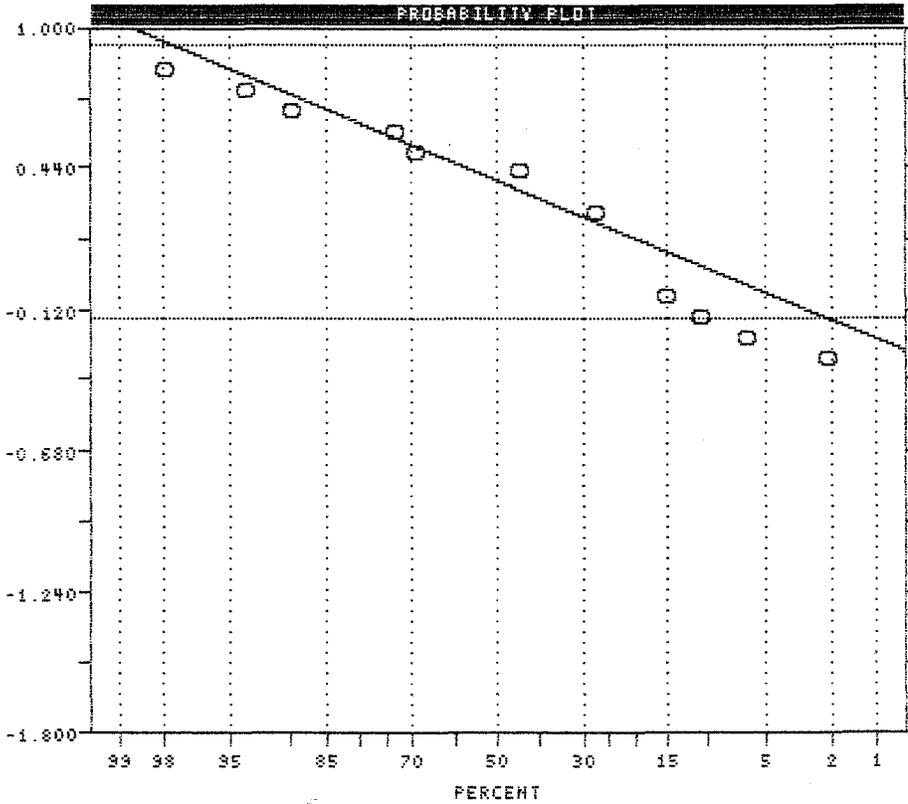
=====

Pop.	Mean	Std.Dev.	%
1	0.3818	0.2722	100.0

Pop. THRESHOLDS

Pop.	Lower	Upper
1	-0.1525	0.9361

RAW DATA ML  
PARAMETER ESTIMATES



14:05:39

RFP / OU-3

05/10/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = CD-1D.DAT

Variable = Cd Unit = MG/K N = 23  
N CI = 14

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

\*\*\*\*\*

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -2.204

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	2.465	- 1.317 + 4.613	100.00

\*\*\*\*\*

13:55:15

RFP / QU-3

06/24/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable = Cr Unit = MG/K N = 39

Mean = 0.9607 Min = 0.3802 1st Quartile = 0.8324  
 Std. Dev. = 0.2192 Max = 1.2529 Median = 1.0191  
 CV % = 22.8170 Skewness = -1.0160 3rd Quartile = 1.1230

Anti-Log Mean = 9.135 Anti-Log Std. Dev. : (-) 5.515  
 (+) 15.134

```
=====
```

%	cum %	antilog	cls int	(# of bins = 16 - bin size = 0.0582)
0.00	1.25	2.245	0.3511	
2.56	3.75	2.566	0.4093	*
2.56	6.25	2.934	0.4675	*
0.00	6.25	3.355	0.5257	
5.13	11.25	3.836	0.5838	**
0.00	11.25	4.385	0.6420	
5.13	16.25	5.014	0.7002	**
0.00	16.25	5.733	0.7584	
5.13	21.25	6.554	0.8165	**
10.26	31.25	7.494	0.8747	****
5.13	36.25	8.568	0.9329	**
7.69	43.75	9.796	0.9911	***
10.26	53.75	11.200	1.0492	****
17.95	71.25	12.806	1.1074	*****
15.38	86.25	14.642	1.1656	*****
7.69	93.75	16.740	1.2238	***
5.13	98.75	19.140	1.2819	**

```
-----
```

0 1 2 3 4

#####

13:56:59

06/24/84

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Cr

UNIT = NG/K

N = 39

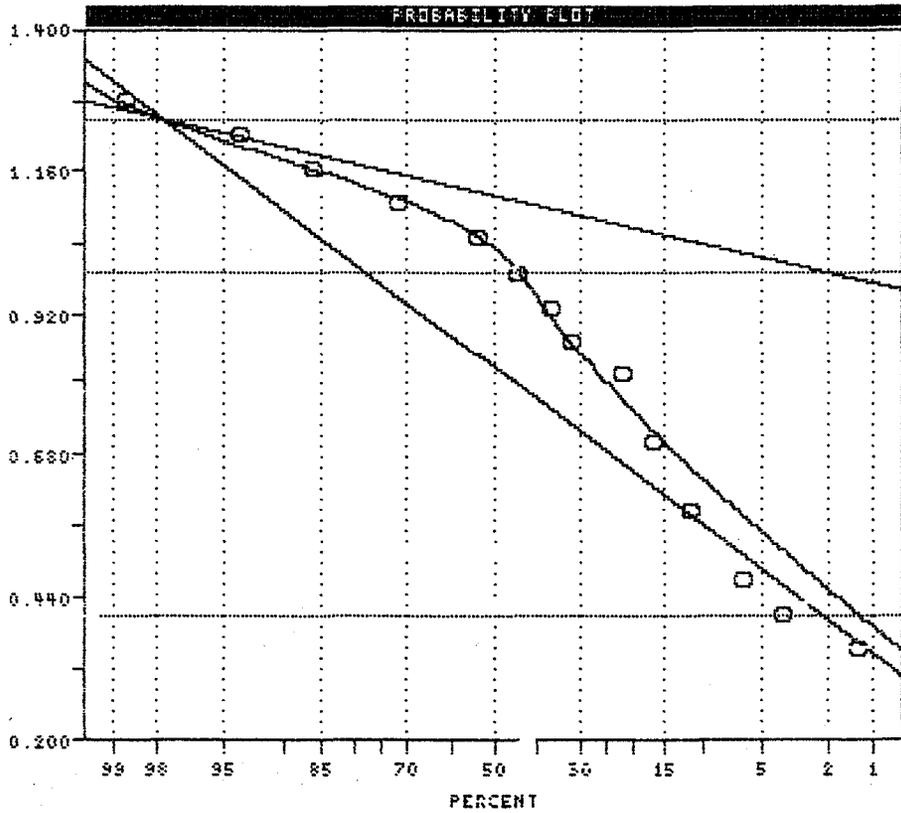
N CI = 16

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.8267	0.2094	54.1
2	1.1172	0.0642	45.9

Pop.	THRESHOLDS	
1	0.4078	1.2455
2	0.9887	1.2457



RAW DATA ML  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:CR-OD.DAT

Variable = Cr Unit = MG/K N = 39  
N CI = 16

Transform = Logarithmic Number of Populations = 2

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 10.980

Parameterized Degrees of Freedom = 3

Population	Mean	Std Dev	Percentage
1	6.709	- 4.142	54.09
		+ 10.866	
2	13.098	- 11.297	45.91
		+ 15.186	

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds	
1	2.557	17.600
2	9.744	17.607

#####

12:34:47

RFP / DU-3

05/10/94

#####  
 SUMMARY STATISTICS and HISTOGRAM  
 #####  
 LOGARITHMIC VALUES

Variable = Cr Unit = MG/K N = 44

Mean = 0.8810 Min = -0.0506 1st Quartile = 0.7076  
 Std. Dev. = 0.3469 Max = 1.5038 Median = 0.9494  
 CV % = 39.3799 Skewness = -0.5172 3rd Quartile = 1.2041

Anti-Log Mean = 7.603 Anti-Log Std. Dev. : (-) 3.420  
 (+) 16.901

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0972)
0.00	1.11	0.796	-0.0992	
2.27	3.33	0.995	-0.0020	*
0.00	3.33	1.245	0.0951	
0.00	3.33	1.557	0.1923	
0.00	3.33	1.947	0.2894	
9.09	12.22	2.435	0.3866	****
6.82	18.89	3.046	0.4837	***
4.55	23.33	3.809	0.5809	**
2.27	25.56	4.764	0.6780	*
6.82	32.22	5.959	0.7752	***
15.91	47.78	7.453	0.8723	*****
6.82	54.44	9.321	0.9695	***
11.36	65.56	11.658	1.0666	*****
6.82	72.22	14.580	1.1638	***
13.64	85.56	18.235	1.2609	*****
11.36	96.67	22.807	1.3581	*****
0.00	96.67	28.524	1.4552	
2.27	98.89	35.675	1.5524	*

0 1 2 3 4

#####

12:35:26  
05/10/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = CP  
UNIT = HG/K  
N = 44  
N CI = 17

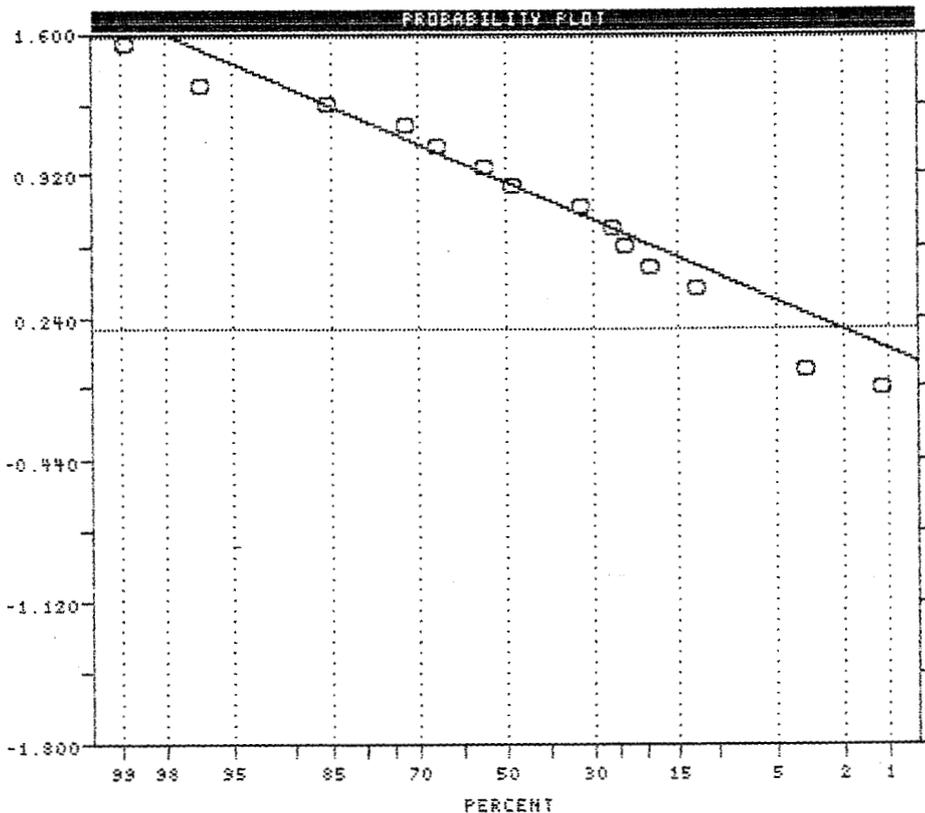
POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.8810	0.2459	100.0

Pop.	THRESHOLDS	
1	0.1871	1.5748

RAW DATA ML  
PARAMETER ESTIMATES



12:36:30

RFP / OU-3

05/10/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = CR-1D.DAT

Variable = Cr Unit = MG/K N = 44  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -15.354

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	7.603	- 3.420 + 16.901	100.00

#####

13:34:22

RFP / OU-3: Cr-S

06/24/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Cr Unit = MG/K N = 18

Mean = 1.1473 Min = 0.7076 1st Quartile = 1.0608  
 Std. Dev. = 0.1673 Max = 1.3444 Median = 1.2175  
 CV % = 14.5839 Skewness = -1.2811 3rd Quartile = 1.2598

Anti-Log Mean = 14.038 Anti-Log Std. Dev. : (-) 9.550  
 (+) 20.636

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0531)
0.00	2.63	4.798	0.6810	
5.56	7.89	5.421	0.7341	*
0.00	7.89	6.126	0.7872	
5.56	13.16	6.922	0.8402	*
0.00	13.16	7.822	0.8933	
0.00	13.16	8.838	0.9464	
5.56	18.42	9.987	0.9994	*
5.56	23.68	11.285	1.0525	*
5.56	28.95	12.752	1.1056	*
16.67	44.74	14.410	1.1587	***
5.56	50.00	16.282	1.2117	*
22.22	71.05	18.399	1.2648	****
22.22	92.11	20.790	1.3179	****
5.56	97.37	23.492	1.3709	*

0 1 2 3 4

#####

13:41:37

06/24/94

RFP / DU-3: Cr-S

LOGARITHMIC VALUES

=====

VARIABLE = Cr

UNIT = MG/K

N = 18

N CI = 13

POPULATIONS

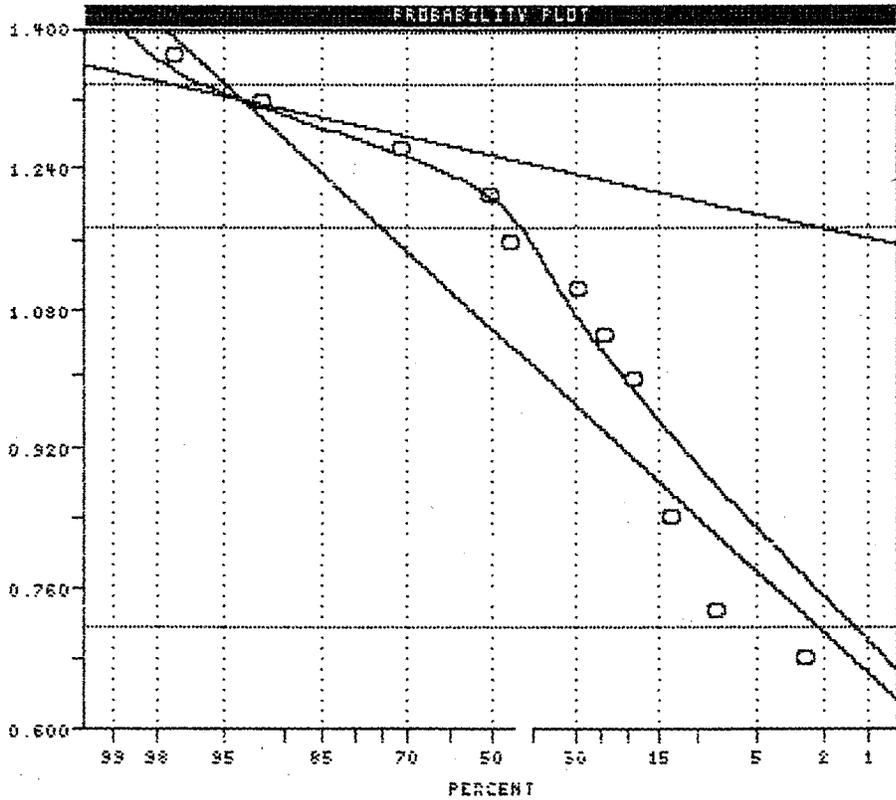
=====

Pop.	Mean	Std. Dev.	%
1	1.0562	0.1704	54.5
2	1.2556	0.0406	45.5

POP. THRESHOLDS

=====

Pop.	Lower	Upper
1	0.7155	1.3969
2	1.1744	1.3369



RAW DATA HL  
PARAMETER ESTIMATES

13:42:48  
06/24/94

RFP / DU-3: Cr-5

LOGARITHMIC VALUES

=====

VARIABLE = Cr  
UNIT = MG/K  
N = 18  
N CI = 13

POPULATIONS

=====

Pop.	Mean	Std.Dev.	X
1	1.0562	0.1704	54.5
2	1.2556	0.0406	45.5

THRESHOLDS

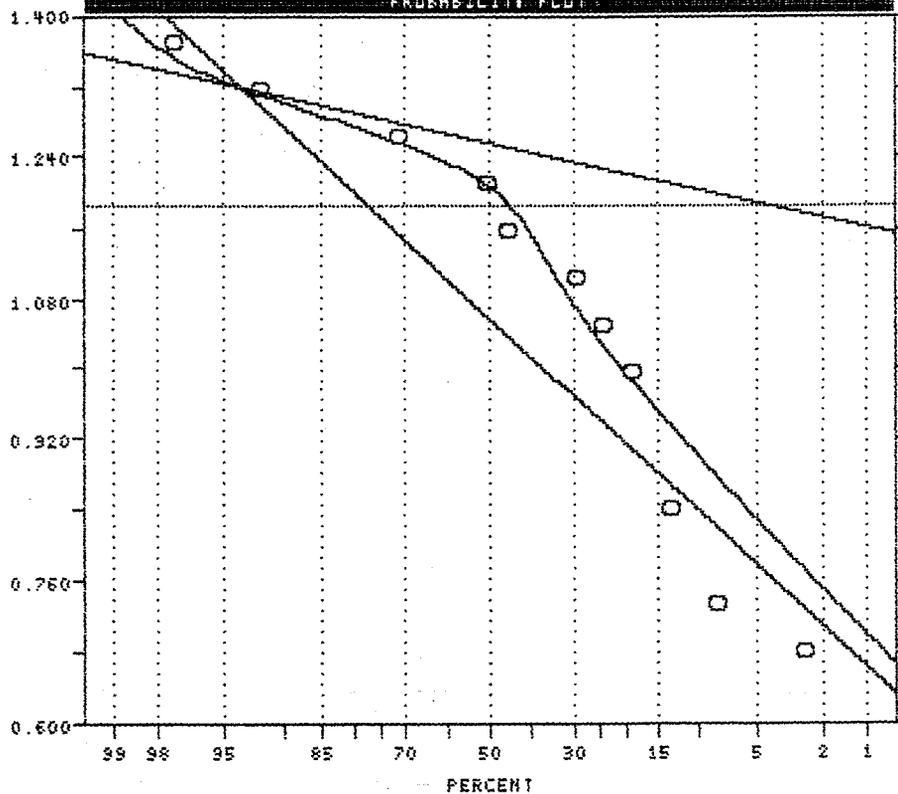
=====

1.1845

RAW DATA ML

PARAMETER ESTIMATES

PROBABILITY PLOT



#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:CR-S.DAT

Variable = Cr Unit = MG/K N = 18  
N CI = 13

Transform = Logarithmic Number of Populations = 2

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 10.973

Parameterized Degrees of Freedom = 3

Population	Mean	Std Dev	Percentage
1	11.381	- 7.688	54.48
		+ 16.848	
2	18.016	- 16.406	45.52
		+ 19.783	

=====

Thresholds Which Minimize Classification Errors.

Thresholds

15.293

#####

18:38:16

RFP / OU-3

05/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable =	Co	Unit =	MG/K	N =	41
Mean =	0.9377	Min =	0.5441	1st Quartile =	0.8751
Std. Dev. =	0.1457	Max =	1.3674	Median =	0.9506
CV % =	15.5333	Skewness =	-0.0992	3rd Quartile =	1.0043
Anti-Log Mean =	8.664	Anti-Log Std. Dev. :	(-)	6.195	
			(+)	12.116	

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0515)
0.00	1.19	3.299	0.5183	
2.44	3.57	3.714	0.5698	*
0.00	3.57	4.181	0.6213	
4.88	8.33	4.707	0.6727	**
2.44	10.71	5.299	0.7242	*
0.00	10.71	5.965	0.7756	
7.32	17.86	6.715	0.8271	***
9.76	27.38	7.560	0.8785	****
14.63	41.67	8.511	0.9300	*****
21.95	63.10	9.582	0.9814	*****
19.51	82.14	10.787	1.0329	*****
7.32	89.29	12.144	1.0844	***
4.88	94.05	13.671	1.1358	**
0.00	94.05	15.391	1.1873	
2.44	96.43	17.327	1.2387	*
0.00	96.43	19.506	1.2902	
0.00	96.43	21.960	1.3416	
2.44	98.81	24.722	1.3931	*

0                    1                    2                    3                    4

#####

18:39:12  
05/08/94

RFP / CU-3

LOGARITHMIC VALUES

=====

VARIABLE = Co  
UNIT = MG/K  
N = 41  
N CI = 17

POPULATIONS

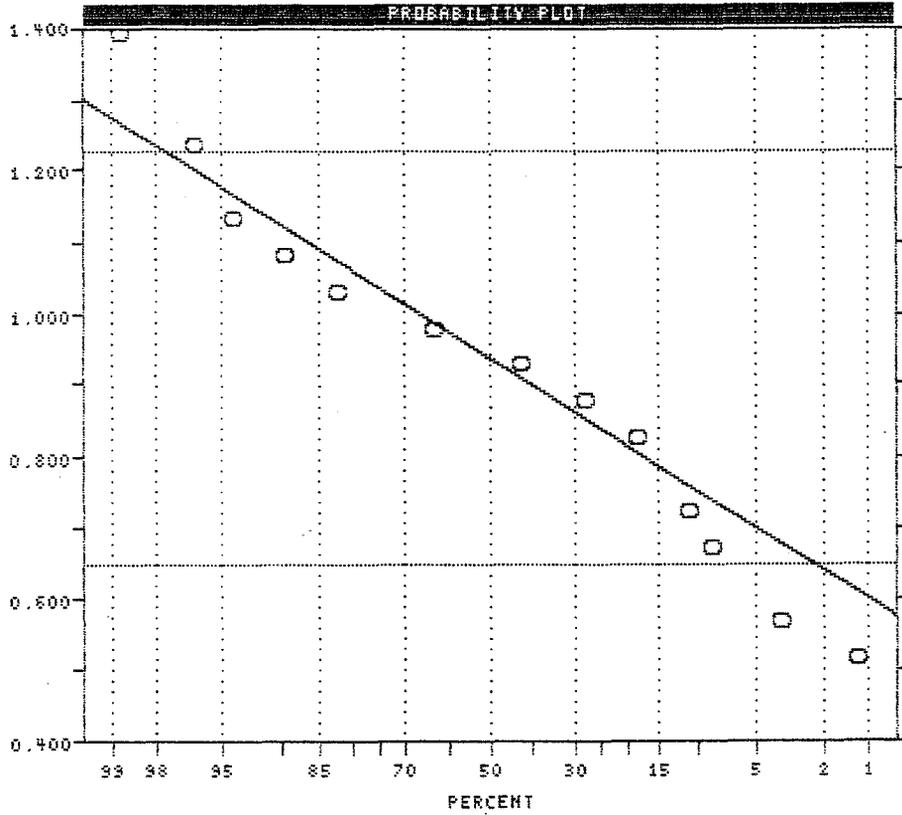
=====

Pop.	Mean	Std.Dev.	%
1	0.9877	0.1457	100.0

POP. THRESHOLDS

-----  
=====

1	0.6464	1.2290
---	--------	--------



RAW DATA HL  
PARAMETER ESTIMATES

18:40:16

RFP / OU-3

05/08/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = CO-OD.DAT

Variable = Co Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 21.311

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	8.664	- 6.195 + 12.116	100.00

\*\*\*\*\*

12:43:42

RFP / OU-3

05/10/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable = Co Unit = MG/K N = 47

Mean = 0.7941 Min = 0.1139 1st Quartile = 0.6307  
 Std. Dev. = 0.2477 Max = 1.1173 Median = 0.8357  
 CV % = 31.1897 Skewness = -1.0523 3rd Quartile = 0.9753

Anti-Log Mean = 6.224 Anti-Log Std. Dev. : (-) 3.519  
 (+) 11.008

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0627)
0.00	1.04	1.209	0.0826	
2.13	3.13	1.397	0.1453	*
4.26	7.29	1.614	0.2080	**
0.00	7.29	1.865	0.2707	
0.00	7.29	2.155	0.3334	
0.00	7.29	2.490	0.3961	
0.00	7.29	2.876	0.4588	
4.26	11.46	3.323	0.5215	**
8.51	19.79	3.839	0.5843	****
4.26	23.96	4.436	0.6470	**
8.51	32.29	5.125	0.7097	****
2.13	34.38	5.921	0.7724	*
14.89	48.96	6.840	0.8351	*****
8.51	57.29	7.903	0.8978	****
17.02	73.96	9.131	0.9605	*****
10.64	84.37	10.549	1.0232	*****
8.51	92.71	12.188	1.0859	****
6.38	98.96	14.081	1.1486	**

0 1 2 3 4

#####

12:44:36  
05/10/94

RFP / BU-3

LOGARITHMIC VALUES

=====

VARIABLE = Co  
UNIT = MG/K  
N = 47  
N CI = 17

POPULATIONS

=====

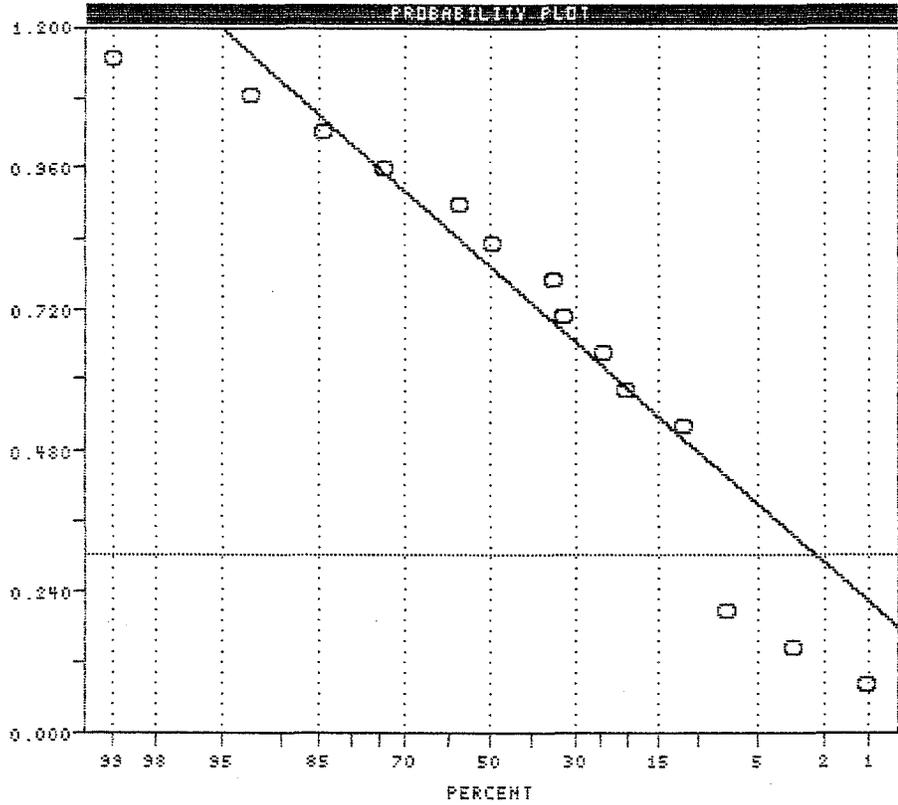
Pop.	Mean	Std.Dev.	%
1	0.7941	0.2477	100.0

POP. THRESHOLDS

Pop.	Lower	Upper
1	0.2387	1.2894

RAH DATA ML

PARAMETER ESTIMATES



12:45:39

RFP / OU-3

05/10/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = CO-1D.DAT

Variable = Co Unit = MG/K N = 47  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -0.593

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	6.224	- 3.519 + 11.008	100.00

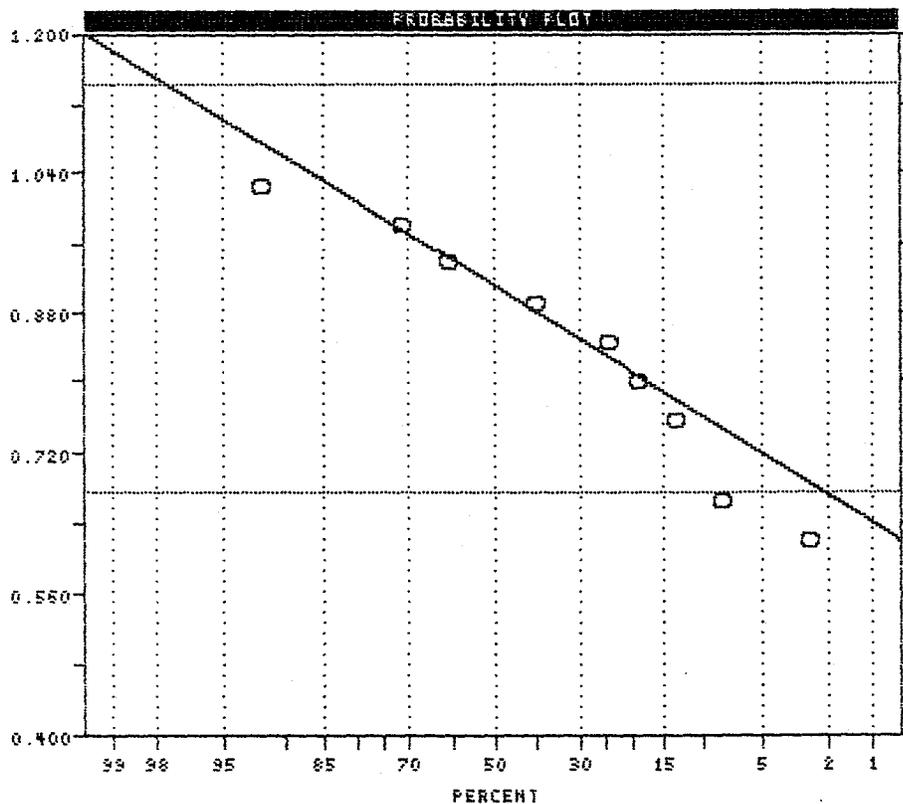
#####



07:46:19  
07/12/94

RFP / DU-3: Co-S

LOGARITHMIC VALUES



=====

VARIABLE =	Co
UNIT =	MG/K
N =	18
N CI =	13

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.9085	0.1167	100.0

THRESHOLDS

=====

1	0.6748	1.1418
---	--------	--------

RAW DATA HL  
PARAMETER ESTIMATES

07:47:17

RFP / DU-3: Co-S

07/12/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:CO-S.DAT

Variable = Co Unit = MG/K N = 18  
N CI = 13

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 13.621

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	8.097	- 6.188 + 10.594	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	4.730 13.860

#####

09:43:43

RFP / 00-3

05/08/94

\*\*\*\*\*  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Fe Unit = MG/K N = 41

Mean = 4.2151 Min = 3.6693 1st Quartile = 4.0828  
 Std. Dev. = 0.2185 Max = 4.7316 Median = 4.2146  
 CV % = 5.1831 Skewness = 0.1694 3rd Quartile = 4.2830

Anti-Log Mean = 16410.384 Anti-Log Std. Dev. : (-) 9923.010  
 (+)27139.014

```

=====
%      cum %      antilog      cls int      (# of bins = 17 - bin size = 0.0664)
-----
0.00   1.19   4326.342   3.6361
2.44   3.57   5040.956   3.7025 *
0.00   3.57   5873.607   3.7689
2.44   5.95   6843.793   3.8353 *
2.44   8.33   7974.232   3.9017 *
2.44  10.71   9291.393   3.9681 *
4.88  15.48  10826.120   4.0345 **
14.63  29.76  12614.349   4.1009 *****
14.63  44.05  14697.952   4.1673 *****
7.32  51.19  17125.719   4.2336 ***
24.39  75.00  19954.498   4.3000 *****
7.32  82.14  23250.527   4.3664 ***
2.44  84.52  27090.985   4.4328 *
4.88  89.29  31565.799   4.4992 **
2.44  91.67  36779.751   4.5656 *
2.44  94.05  42854.929   4.6320 *
0.00  94.05  49933.587   4.6984
4.88  98.81  58181.480   4.7648 **
=====

```

0 1 2 3 4

\*\*\*\*\*

09:44:38

05/09/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Fe

UNIT = MG/K

N = 41

N CI = 17

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	4.2151	0.2185	100.0

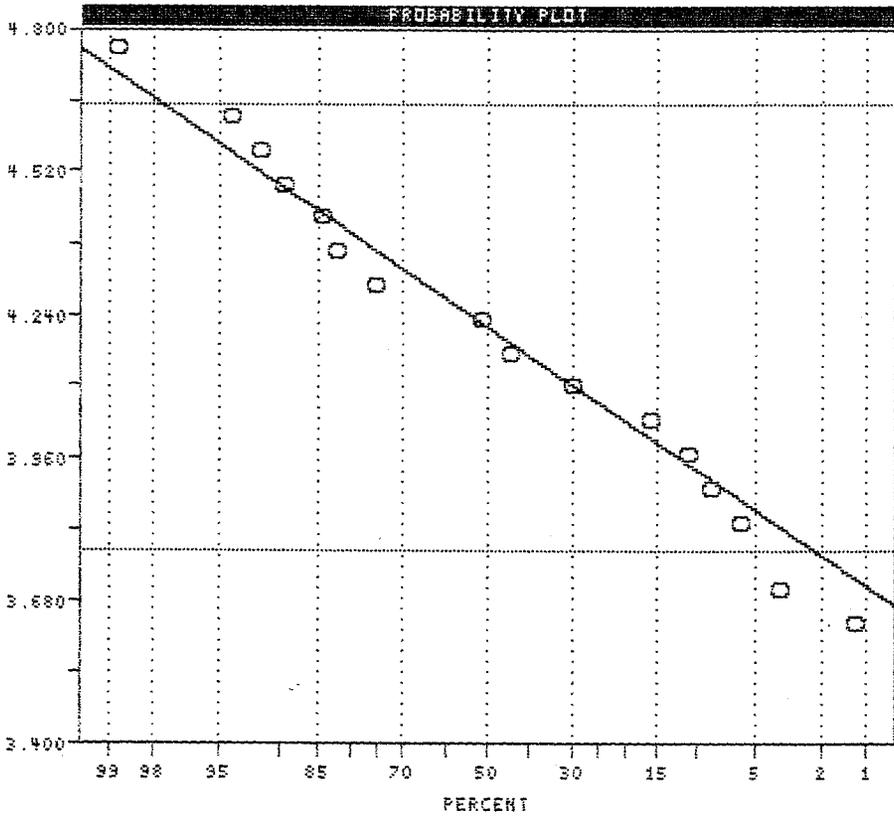
POP. THRESHOLDS

=====

1	3.7782	4.6521
---	--------	--------

RAW DATA HL

PARAMETER ESTIMATES



09:48:04

RFP / 00-3

05/08/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = FE-OD.DAT

Variable = Fe Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 4.688

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	16410.384	- 9923.010 + 27139.014	100.00

#####

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable = Fe Unit = MG/K N = 47

Mean = 4.1180 Min = 3.4914 1st Quartile = 4.0065  
 Std. Dev. = 0.2167 Max = 4.4314 Median = 4.1507  
 CV % = 5.2621 Skewness = -0.7918 3rd Quartile = 4.2900

Anti-Log Mean = 13123.397 Anti-Log Std. Dev. : (-) 7968.033  
 (+)21614.311

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0588)
0.00	1.04	2897.254	3.4620	
2.13	3.13	3316.933	3.5207	*
0.00	3.13	3797.405	3.5795	
2.13	5.21	4347.474	3.6382	*
2.13	7.29	4977.224	3.6970	*
2.13	9.38	5698.195	3.7557	*
0.00	9.38	6523.601	3.8145	
2.13	11.46	7468.571	3.8732	*
8.51	19.79	8550.424	3.9320	****
2.13	21.88	9788.988	3.9907	*
8.51	30.21	11206.963	4.0495	****
14.89	44.79	12830.337	4.1082	*****
10.64	55.21	14688.863	4.1670	*****
10.64	65.63	16816.605	4.2257	*****
8.51	73.96	19252.558	4.2845	****
12.77	86.46	22041.369	4.3432	*****
6.38	92.71	25234.151	4.4020	***
6.38	98.96	28889.420	4.4607	***

0 1 2 3 4

#####

12:07:55  
05/10/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Fe  
UNIT = MG/K  
N = 47  
N CI = 17

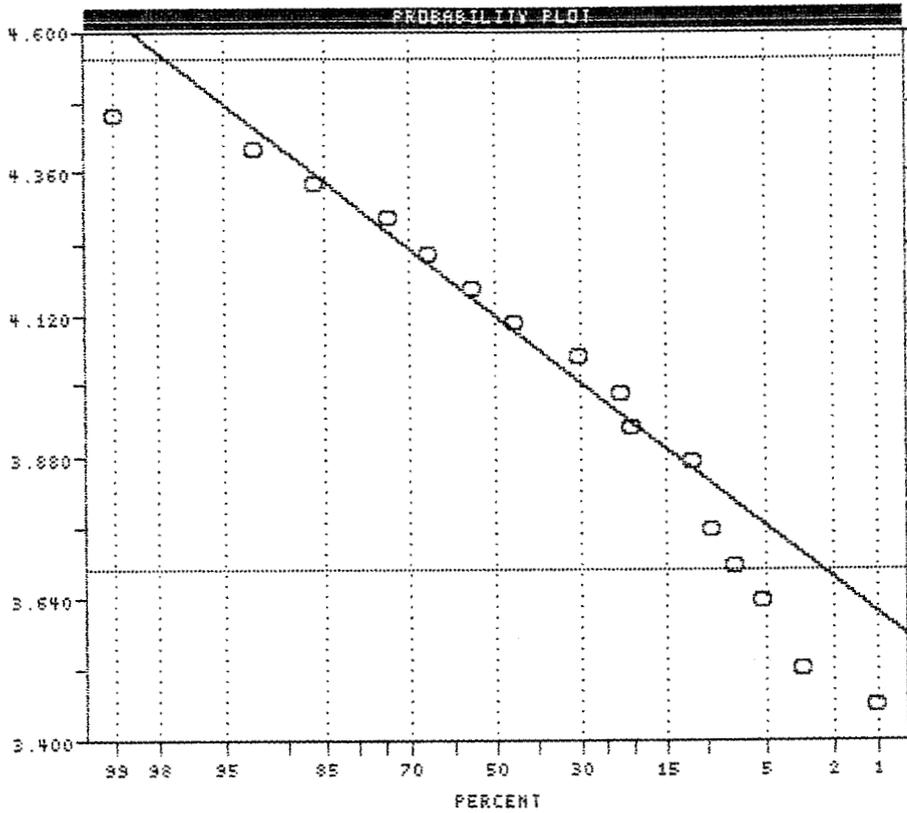
POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	4.1180	0.2167	100.0

THRESHOLDS

Pop.	Lower	Upper
1	3.6847	4.5514



RAW DATA ML  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = FE-1D.DAT

Variable = Fe Unit = MG/K N = 47  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 5.685

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	13123.397	- 7968.033 + 21614.311	100.00

#####

10:54:07

RFP / DU-3: Fe-S

05/03/9

#####  
 SUMMARY STATISTICS and HISTOGRAM  
 LOGARITHMIC VALUE

Variable = Fe Unit = MG/K N = 19  
 Mean = 4.2706 Min = 4.0334 1st Quartile = 4.1461  
 Std. Dev. = 0.1425 Max = 4.6812 Median = 4.2623  
 CV % = 3.3366 Skewness = 0.9524 3rd Quartile = 4.3344  
 Anti-Log Mean = 18646.115 Anti-Log Std. Dev. : (-)13430.562  
 (+)25887.048

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0540)
0.00	2.50	10149.189	4.0064	
5.26	7.50	11492.543	4.0604	*
5.26	12.50	13013.704	4.1144	*
15.79	27.50	14736.208	4.1684	***
5.26	32.50	16686.702	4.2224	*
21.05	52.50	18895.366	4.2764	****
21.05	72.50	21396.370	4.3303	****
15.79	87.50	24228.409	4.3843	***
5.26	92.50	27435.298	4.4383	*
0.00	92.50	31066.653	4.4923	
0.00	92.50	35178.658	4.5463	
0.00	92.50	39834.929	4.6003	
0.00	92.50	45107.509	4.6542	
5.26	97.50	51077.970	4.7082	*

#####

10:55:31  
05/03/94

RFP / DU-3: Fe-S

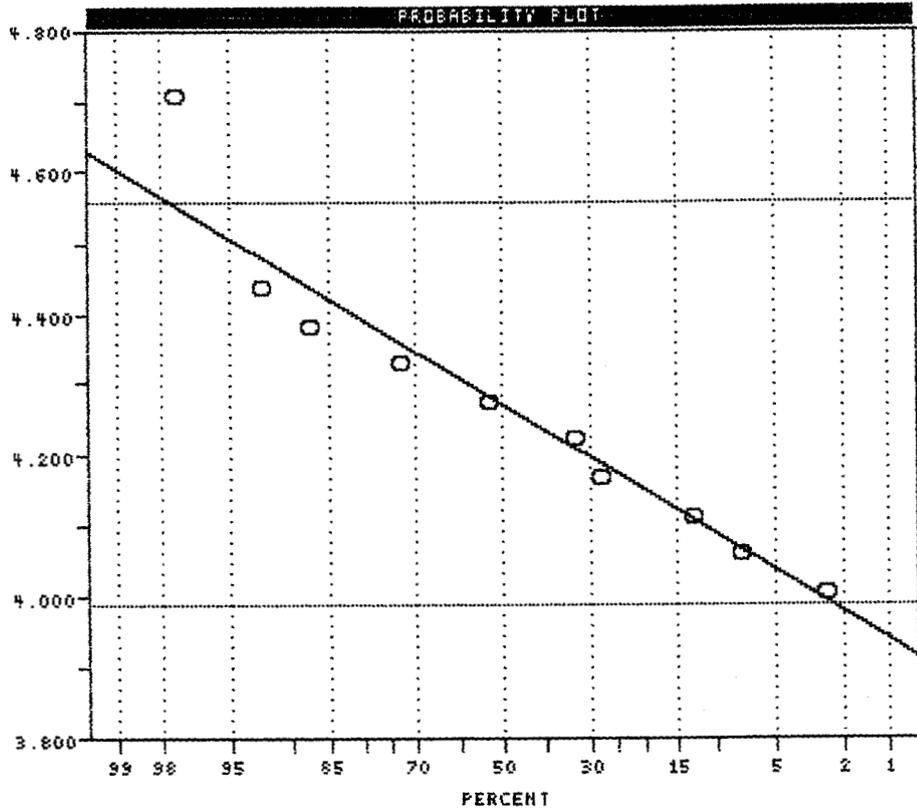
LOGARITHMIC VALUES

VARIABLE = Fe  
UNIT = MG/K  
N = 19  
N CI = 13

POPULATIONS

Pop.	Mean	Std.Dev.	%
1	4.2706	0.1425	100.0

Pop.	THRESHOLDS	
1	3.9856	4.5556



RAW DATA ML  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:FE-S.DAT

Variable = Fe Unit = MG/K N = 19  
N CI = 13

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 10.561

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	18646.115	- 13430.562 + 25887.048	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	9673.865 35939.886

#####



09:40:58

05/07/94

RFF / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Pb  
 UNIT = MG/K  
 N = 41  
 N CI = 17

POPULATIONS

=====

Pop.	Mean	Std.Dev.	x
1	1.3819	0.2315	100.0

POP. THRESHOLDS

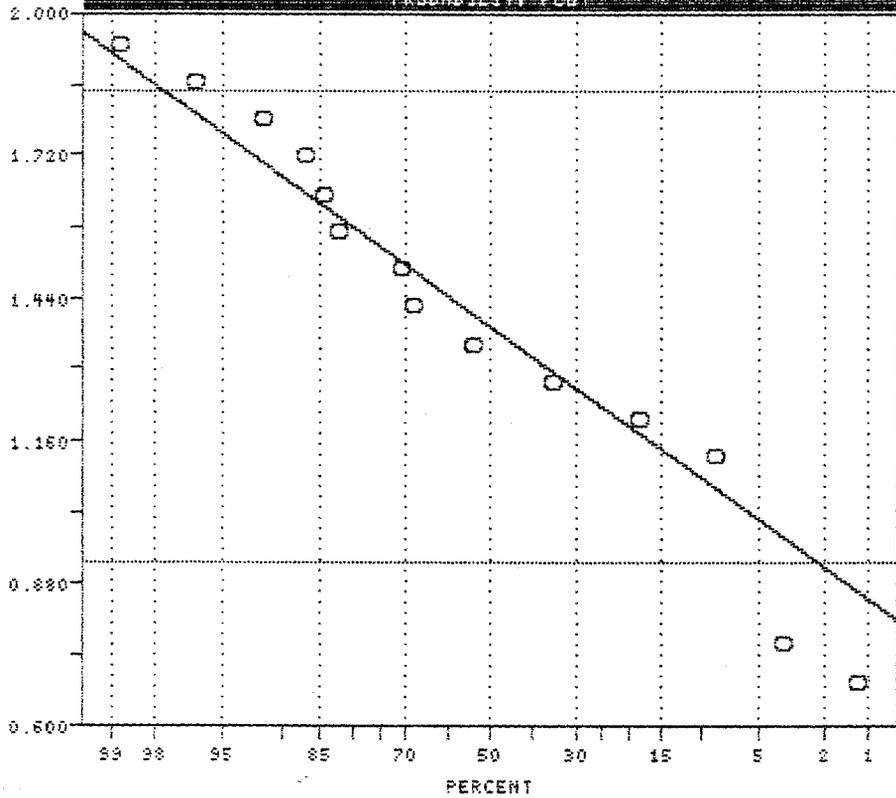
-----

1	0.9129	1.8449
---	--------	--------

RAW DATA ML

PARAMETER ESTIMATES

PROBABILITY PLOT



09:42:03

RFP / OU-3

05/07/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = PE-OD.DAT

Variable = Pb Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 2.316

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	24.093	- 14.139 + 41.056	100.00

#####

17:44:24

RFP / QU-3

05/09/94

\*\*\*\*\*  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Pb	Unit =	MB/K	N =	47
Mean =	1.4841	Min =	0.4624	1st Quartile =	1.0606
Std. Dev. =	0.4963	Max =	2.2788	Median =	1.4081
CV % =	33.4429	Skewness =	-0.1797	3rd Quartile =	1.9444
Anti-Log Mean =	30.483	Anti-Log Std. Dev. :	(-)	9.722	
			(+)	95.579	

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.1135)
0.00	1.04	2.545	0.4056	
2.13	3.13	3.305	0.5192	*
0.00	3.13	4.292	0.6327	
6.38	9.38	5.574	0.7462	***
6.38	15.63	7.240	0.8597	***
4.26	19.79	9.403	0.9732	**
6.38	26.04	12.212	1.0868	***
2.13	28.13	15.860	1.2003	*
12.77	40.63	20.598	1.3138	*****
8.51	48.96	26.751	1.4273	****
4.26	53.13	34.742	1.5409	**
4.26	57.29	45.121	1.6544	**
8.51	65.63	58.601	1.7679	****
2.13	67.71	76.107	1.8814	*
12.77	80.21	98.843	1.9949	*****
8.51	88.54	128.372	2.1085	****
8.51	96.87	166.722	2.2220	****
2.13	98.96	216.528	2.3355	*

0 1 2 3 4

\*\*\*\*\*

17:47:02

05/03/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = PD

UNIT = MG/K

N = 47

N CI = 17

POPULATIONS

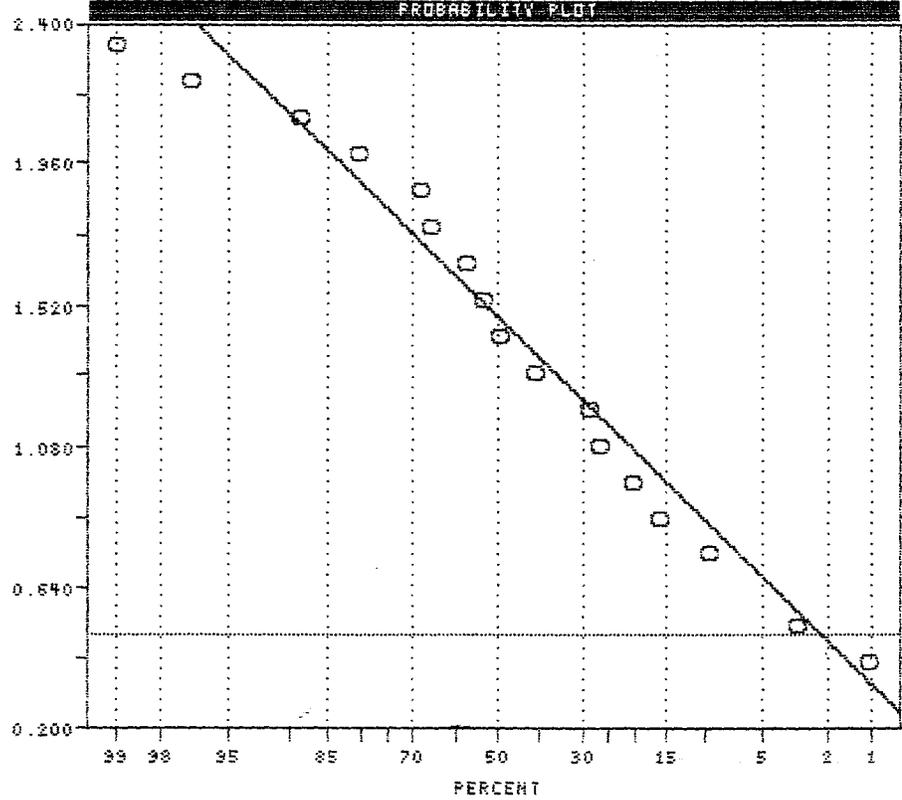
=====

Pop.	Mean	Std.Dev.	%
1	1.4841	0.4963	100.0

POP. THRESHOLDS

=====

1	0.4914	2.4767
---	--------	--------



RAW DATA ML  
PARAMETER ESTIMATES

17:49:11

RFP / GU-3

05/09/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = PB-1D.DAT

Variable = Pb Unit = MG/K N = 47  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -33.264

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	30.483	- 9.722 + 95.579	100.00

#####

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Pb Unit = MG/K N = 19

Mean = 1.4087 Min = 1.0899 1st Quartile = 1.2161  
 Std. Dev. = 0.1609 Max = 1.6107 Median = 1.4661  
 CV % = 11.4213 Skewness = -0.5830 3rd Quartile = 1.5431

Anti-Log Mean = 25.626 Anti-Log Std. Dev. : (-) 17.693  
 (+) 37.117

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0434)
0.00	2.50	11.701	1.0682	
5.26	7.50	12.930	1.1116	*
0.00	7.50	14.289	1.1550	
5.26	12.50	15.790	1.1984	*
15.79	27.50	17.450	1.2418	***
0.00	27.50	19.284	1.2852	
0.00	27.50	21.310	1.3286	
10.53	37.50	23.549	1.3720	**
5.26	42.50	26.024	1.4154	*
0.00	42.50	28.759	1.4588	
21.05	62.50	31.781	1.5022	****
21.05	82.50	35.121	1.5456	****
10.53	92.50	38.812	1.5890	**
5.26	97.50	42.890	1.6324	*

0 1 2 3 4

#####

15:40:35  
07/08/94

RFP / DU-3: Pd-S

LOGARITHMIC VALUES

=====

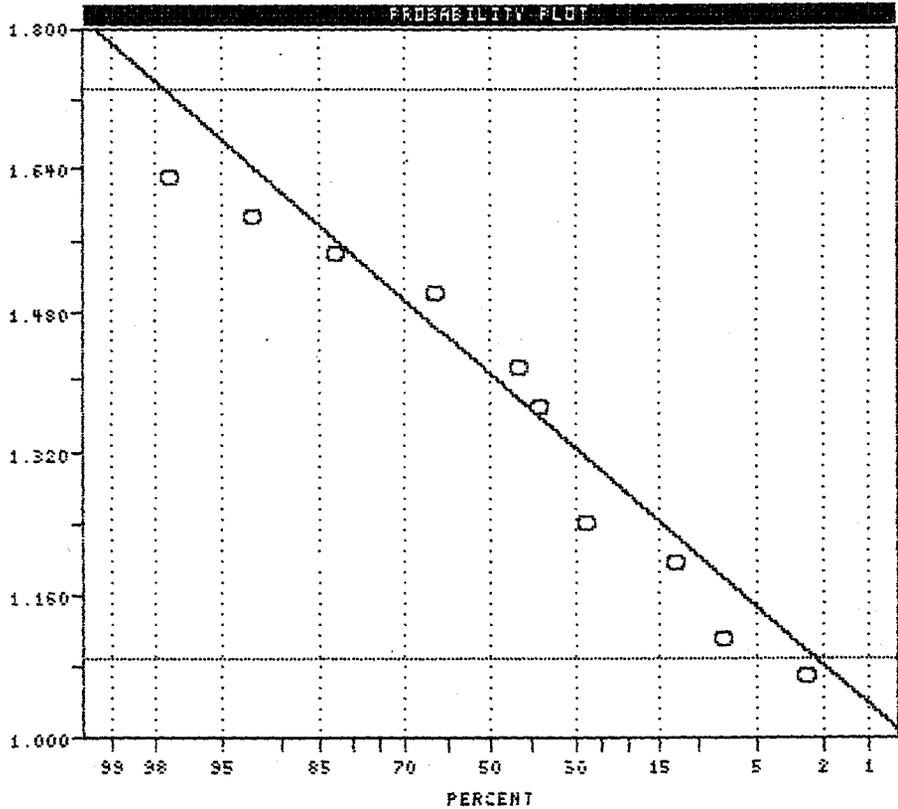
VARIABLE = Pd  
UNIT = MG/K  
N = 19  
N CI = 13

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	1.4087	0.1609	100.0

Pop.	THRESHOLDS	
1	1.0869	1.7305



RAW DATA ML  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:PB-S.DAT

Variable = Pb Unit = MG/K N = 19  
N CI = 13

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 8.254

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	25.626	- 17.693 + 37.117	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	12.215 53.760

#####

09:22:44

RFP / GU-3

05/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Li	Unit =	MG/K	N =	41
Mean =	0.8936	Min =	0.2553	1st Quartile =	0.8062
Std. Dev. =	0.1897	Max =	1.2455	Median =	0.9395
CV % =	21.2308	Skewness =	-1.0746	3rd Quartile =	1.0000
Anti-Log Mean =	7.827	Anti-Log Std. Dev. :	(-)	5.057	
			(+)	12.115	

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0619)
0.00	1.19	1.676	0.2243	
2.44	3.57	1.933	0.2862	*
0.00	3.57	2.229	0.3481	
0.00	3.57	2.570	0.4100	
0.00	3.57	2.964	0.4719	
2.44	5.95	3.418	0.5338	*
0.00	5.95	3.942	0.5957	
7.32	13.10	4.545	0.6576	***
2.44	15.48	5.241	0.7194	*
7.32	22.62	6.044	0.7813	***
12.20	34.52	6.970	0.8432	*****
7.32	41.67	8.037	0.9051	***
21.95	63.10	9.268	0.9670	*****
14.63	77.38	10.688	1.0289	*****
12.20	89.29	12.325	1.0908	*****
7.32	96.43	14.213	1.1527	***
0.00	96.43	16.390	1.2146	
2.44	98.81	18.900	1.2765	*

0                    1                    2                    3                    4

#####

09:23:49

05/08/94

RFF / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Li

UNIT = MG/K

N = 41

N CI = 17

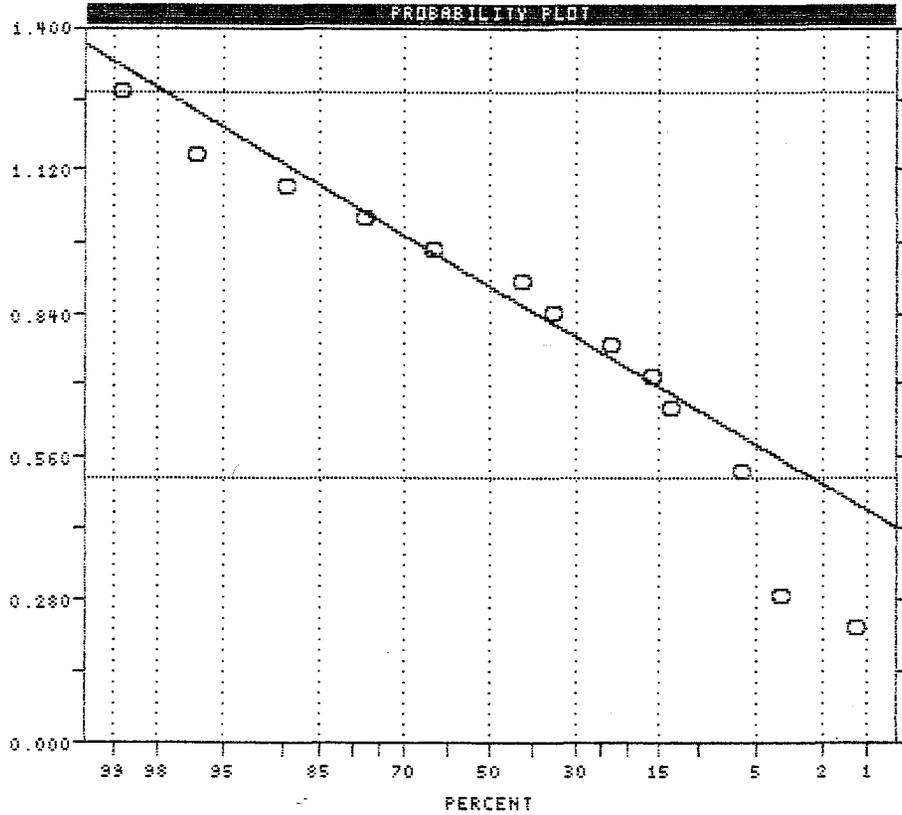
POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.8936	0.1897	100.0

Pop. THRESHOLDS

Pop.	Lower	Upper
1	0.5142	1.2730



RAW DATA HL  
PARAMETER ESTIMATES

09:24:55

RFP / DU-3

05/08/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = LI-OD.DAT

Variable = Li Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 10.474

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	7.827	- 5.057 + 12.115	100.00

#####

19:12:29

RFP / DU-3

05/09/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Li	Unit =	MG/K	N =	46
Mean =	0.7679	Min =	-0.2757	1st Quartile =	0.5966
Std. Dev. =	0.3684	Max =	1.5391	Median =	0.7782
CV % =	47.9721	Skewness =	-0.8768	3rd Quartile =	1.0374
Anti-Log Mean =	5.861	Anti-Log Std. Dev. :	(-)	2.509	
			(+)	13.689	

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.1134)
0.00	1.06	0.465	-0.3324	
2.17	3.19	0.604	-0.2190	*
2.17	5.32	0.784	-0.1056	*
2.17	7.45	1.018	0.0078	*
0.00	7.45	1.322	0.1213	
2.17	9.57	1.717	0.2347	*
2.17	11.70	2.229	0.3481	*
0.00	11.70	2.894	0.4615	
10.87	22.34	3.758	0.5750	*****
15.22	37.23	4.880	0.6884	*****
15.22	52.13	6.336	0.8018	*****
2.17	54.26	8.227	0.9152	*
17.39	71.28	10.682	1.0287	*****
17.39	88.30	13.870	1.1421	*****
8.70	96.81	18.010	1.2555	****
0.00	96.81	23.385	1.3689	
0.00	96.81	30.364	1.4824	
2.17	98.94	39.427	1.5958	*

0 1 2 3 4

#####

19:13:02  
05/09/94

RFF / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = L1  
UNIT = MG/K  
N = 46  
N CI = 17

POPULATIONS

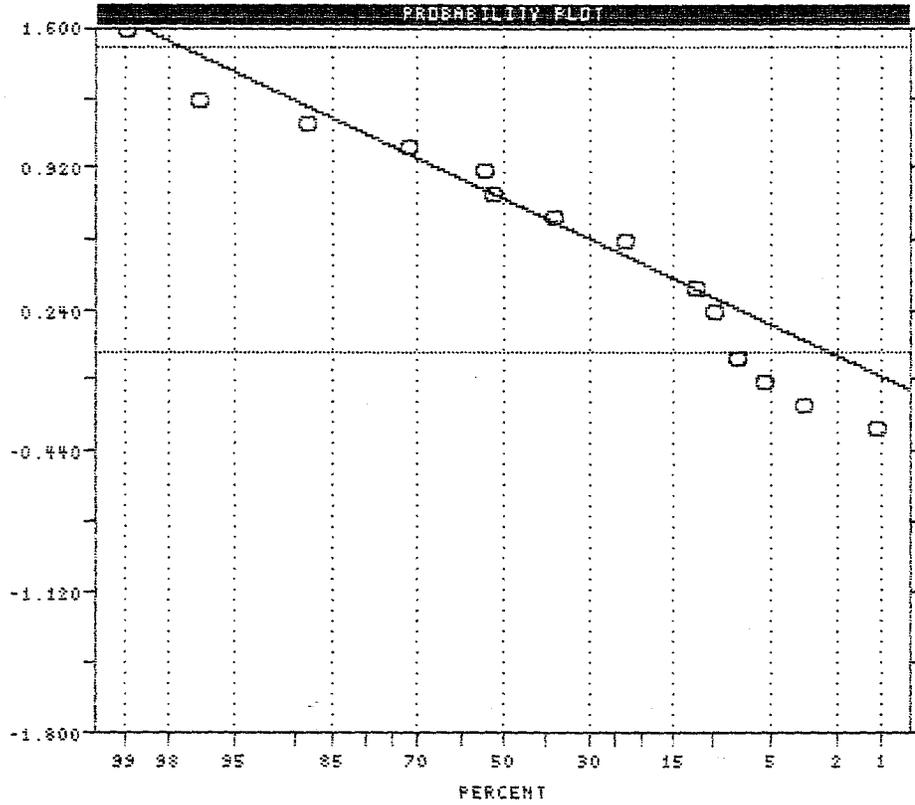
=====

Pop.	Mean	Std.Dev.	%
1	0.7679	0.3684	100.0

Pop.	THRESHOLDS	
1	0.0311	1.5047

RAW DATA ML

PARAMETER ESTIMATES



19:14:05

RFP / OU-3

05/09/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = LI-1D.DAT

Variable = Li Unit = MG/K N = 46  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -18.836

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	5.861	- 2.509 + 13.688	100.00

#####

07:40:43

RFP / DU-3: Li-6

07/12/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Li	Unit =	MG/K	N =	18
Mean =	1.0204	Min =	0.8451	1st Quartile =	0.8889
Std. Dev. =	0.1183	Max =	1.2095	Median =	1.0453
CV % =	11.5967	Skewness =	-0.1882	3rd Quartile =	1.1271
Anti-Log Mean =	10.480	Anti-Log Std. Dev. :	(-)	7.980	
			(+)	13.762	

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0304)
0.00	2.63	6.759	0.8299	
16.67	18.42	7.249	0.8603	***
5.56	23.68	7.774	0.8907	*
5.56	28.95	8.337	0.9210	*
5.56	34.21	8.941	0.9514	*
0.00	34.21	9.589	0.9818	
16.67	50.00	10.283	1.0121	***
0.00	50.00	11.028	1.0425	
5.56	55.26	11.827	1.0729	*
11.11	65.79	12.683	1.1032	**
16.67	81.58	13.602	1.1336	***
11.11	92.11	14.587	1.1640	**
0.00	92.11	15.643	1.1943	
5.56	97.37	16.776	1.2247	*

-----

0                    1                    2                    3                    4

#####

07:41:56

07/12/84

RFP / DU-3: Li-5

LOGARITHMIC VALUES

=====

VARIABLE = Li

UNIT = MG/K

N = 18

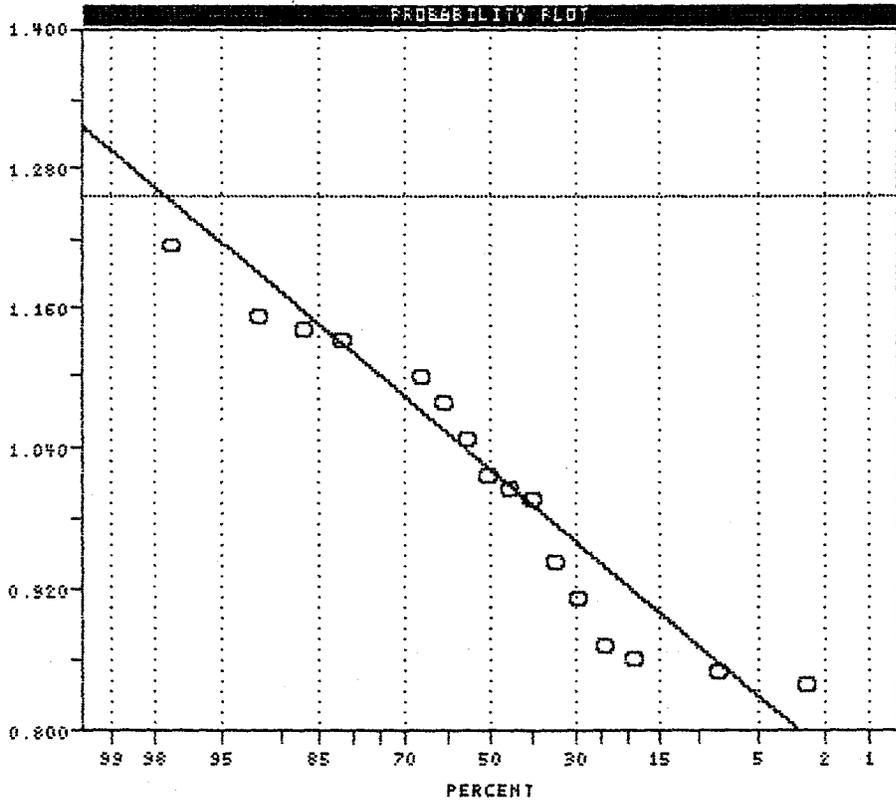
N CI = 36

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	1.0204	0.1183	100.0

Pop.	THRESHOLDS	
1	0.7837	1.2570



RAW DATA HL  
PARAMETER ESTIMATES

07:42:55

RFP / OU-3: Li-S

07/12/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:LI-S.DAT

Variable = Li Unit = MG/K N = 18  
N CI = 36

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 13.376

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	10.480	- 7.980 + 13.762	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	6.077 18.072

#####

08:56:53

RFP / OU-3

05/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM  
 LOGARITHMIC VALUES

Variable = Mn Unit = MG/K N = 41  
 Mean = 2.5782 Min = 1.6075 1st Quartile = 2.4381  
 Std. Dev. = 0.3260 Max = 3.1903 Median = 2.6448  
 CV % = 12.6449 Skewness = -1.0570 3rd Quartile = 2.7493  
 Anti-Log Mean = 378.649 Anti-Log Std. Dev. : (-) 178.740  
 (+) 802.147

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0989)
0.00	1.19	36.140	1.5580	
2.44	3.57	45.386	1.6569	*
2.44	5.95	56.997	1.7558	*
0.00	5.95	71.578	1.8548	
2.44	8.33	89.890	1.9537	*
0.00	8.33	112.886	2.0526	
0.00	8.33	141.765	2.1516	
4.88	13.10	178.032	2.2505	**
4.88	17.86	223.578	2.3494	**
9.76	27.38	280.775	2.4484	***
9.76	36.90	352.605	2.5473	***
12.20	48.81	442.810	2.6462	****
24.39	72.62	556.093	2.7451	*****
9.76	82.14	698.357	2.8441	****
12.20	94.05	877.015	2.9430	*****
0.00	94.05	1101.380	3.0419	
0.00	94.05	1383.142	3.1409	
4.88	98.81	1736.987	3.2398	**

0 1 2 3 4

#####

08:57:57  
05/08/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Mn  
UNIT = MG/K  
N = 41  
W CI = 17

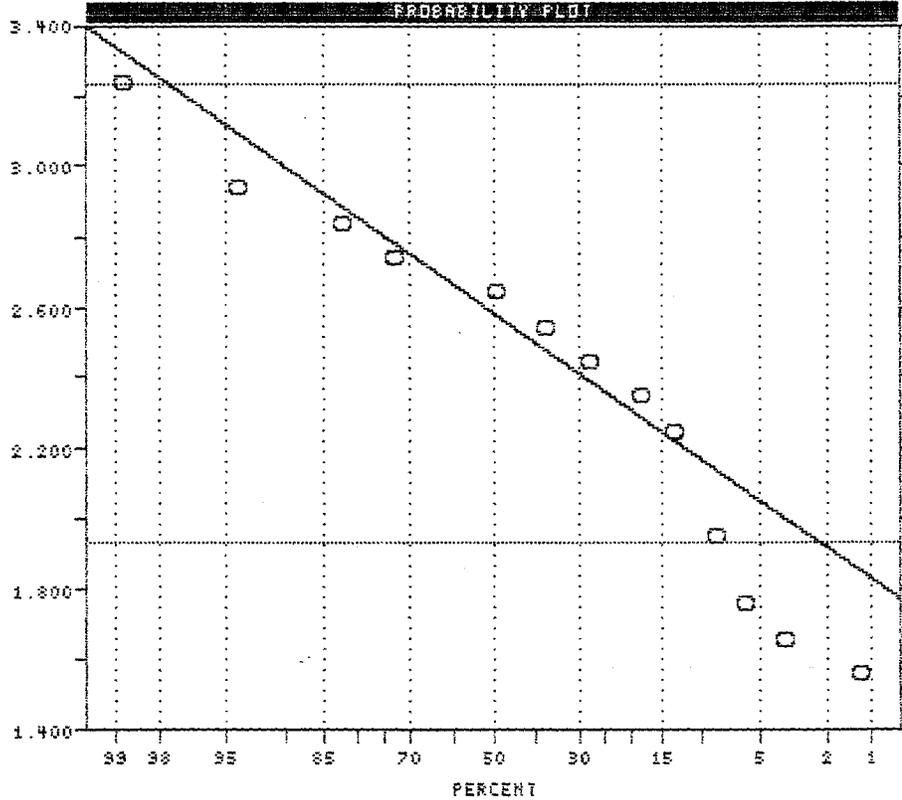
POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	2.5782	0.3260	100.0

THRESHOLDS

1	1.9262	3.2303
---	--------	--------



RAW DATA ML  
PARAMETER ESTIMATES

08:59:01

RFP / OU-3

05/08/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = MN-OD.DAT

Variable = Mn Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

-----

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -11.723

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	378.649	- 178.740 + 802.147	100.00

\*\*\*\*\*

18:58:31

RFP / DU-3

05/09/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable =	Mn	Unit =	MG/K	N =	47
Mean =	2.6529	Min =	1.9217	1st Quartile =	2.2928
Std. Dev. =	0.4725	Max =	3.6484	Median =	2.5451
CV % =	17.8110	Skewness =	0.4064	3rd Quartile =	3.0290
Anti-Log Mean =	449.627	Anti-Log Std. Dev. :	(-) 151.479	(+)	1334.602

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.1079)
0.00	1.04	73.744	1.8677	
8.51	9.38	94.546	1.9756	****
4.26	13.54	121.217	2.0836	**
2.13	15.63	155.410	2.1915	*
8.51	23.96	199.249	2.2994	****
14.89	38.54	255.454	2.4073	*****
6.38	44.79	327.514	2.5152	***
12.77	57.29	419.902	2.6231	*****
6.38	63.54	538.350	2.7311	***
0.00	63.54	690.211	2.8390	
8.51	71.88	884.910	2.9469	****
4.26	76.04	1134.530	3.0548	**
4.26	80.21	1454.565	3.1627	**
2.13	82.29	1864.877	3.2707	*
8.51	90.62	2390.932	3.3786	****
4.26	94.79	3065.380	3.4865	**
2.13	96.87	3930.081	3.5944	*
2.13	98.96	5038.701	3.7023	*

0                    1                    2                    3                    4

#####

18:59:14

05/03/94

RFP / DU-3

LOGARITHMIC VALUES

=====

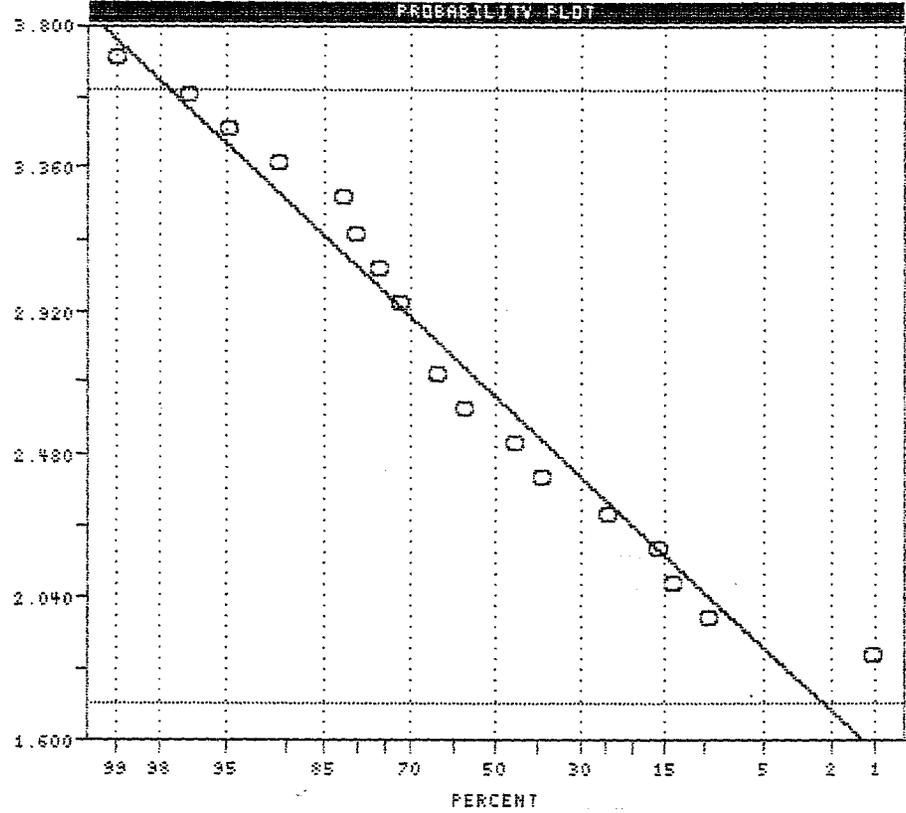
VARIABLE = Mn  
 UNIT = MG/K  
 N = 47  
 N CI = 17

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	2.6529	0.4725	100.0

Pop.	THRESHOLDS	
1	1.7079	3.5979



RAW DATA HL  
 PARAMETER ESTIMATES

19:00:17

RFP / OU-3

05/09/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = MN-1D.DAT

Variable = Mn Unit = MG/K N = 47  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

\*\*\*\*\*

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -30.953

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	449.627	- 151.479 + 1334.602	100.00

\*\*\*\*\*

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	51.033 3961.425

\*\*\*\*\*

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Mn	Unit =	MG/K	N =	19
Mean =	2.4683	Min =	2.1703	1st Quartile =	2.2861
Std. Dev. =	0.2407	Max =	3.0682	Median =	2.3993
CV % =	9.7537	Skewness =	1.1077	3rd Quartile =	2.5473
Anti-Log Mean =		293.937	Anti-Log Std. Dev. :		(-) 168.852
					(+) 511.684

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0748)	
0.00	2.50	135.784	2.1328		
10.53	12.50	161.315	2.2077	**	
5.26	17.50	191.647	2.2825	*	
21.05	37.50	227.682	2.3573	****	
15.79	52.50	270.493	2.4322	***	
10.53	62.50	321.354	2.5070	**	
15.79	77.50	381.777	2.5818	***	
5.26	82.50	453.563	2.6566	*	
5.26	87.50	538.846	2.7315	*	
0.00	87.50	640.164	2.8063		
0.00	87.50	760.533	2.8811		
0.00	87.50	903.536	2.9559		
5.26	92.50	1073.427	3.0308	*	
5.26	97.50	1275.262	3.1056	*	

0 1 2 3 4

#####

13:32:55  
06/24/34

RFP / DU-3: Mn-S

LOGARITHMIC VALUES

=====

VARIABLE = Mn  
UNIT = MG/K  
N = 19  
N CI = 13

POPULATIONS

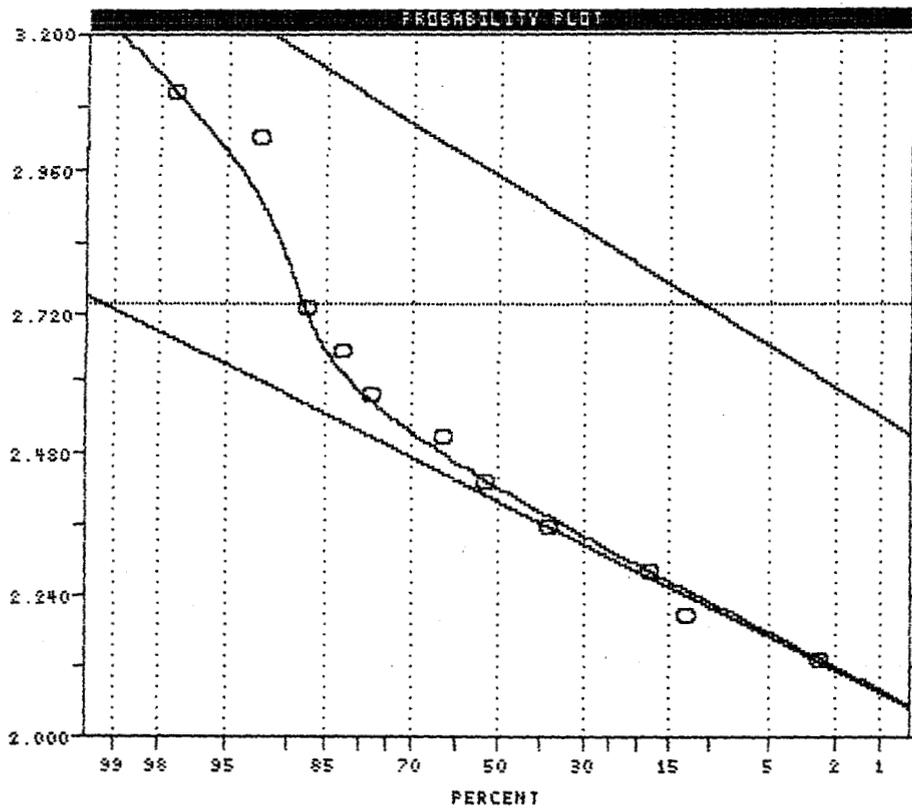
=====

Pop.	Mean	Std.Dev.	%
1	2.3978	0.1406	87.3
2	2.9556	0.1787	12.7

THRESHOLDS

=====

2.7374



RAW DATA ML  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:MN-S.DAT

Variable = Mn Unit = MG/K N = 19  
N CI = 13

Transform = Logarithmic Number of Populations = 2

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 3.903

Parameterized Degrees of Freedom = 3

Population	Mean	Std Dev	Percentage
1	249.941	- 180.820	87.32
		+ 345.484	
2	902.784	- 598.201	12.68
		+ 1362.450	

=====

Thresholds Which Minimize Classification Errors.

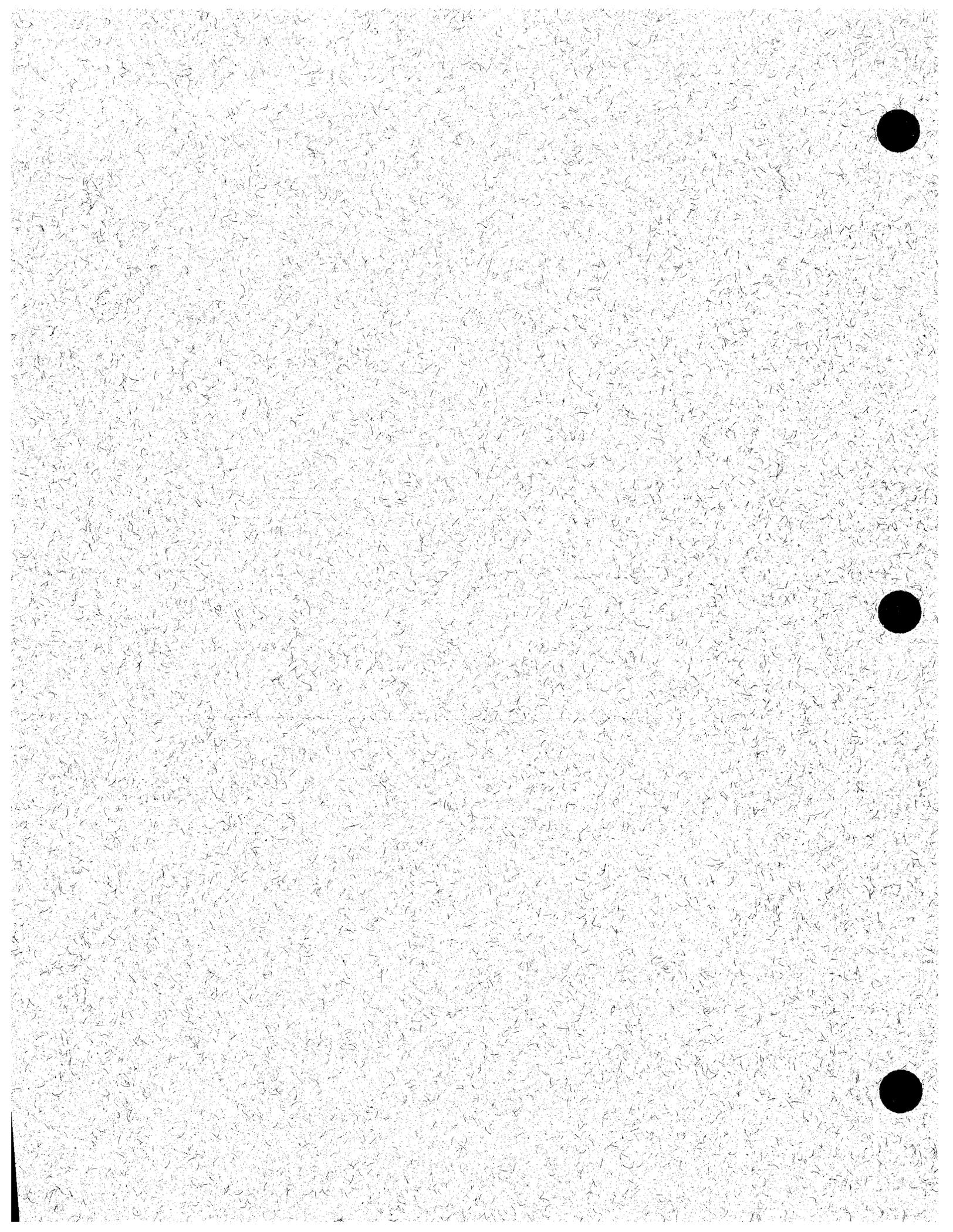
Thresholds

-----  
546.253

#####

---

**MERCURY**  
**IHSS 201, Standley Lake**



#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Hg Unit = MG/K N = 21  
 Mean = -0.7680 Min = -1.0969 1st Quartile = -0.9303  
 Std. Dev. = 0.2409 Max = -0.2218 Median = -0.8389  
 CV % = 31.3617 Skewness = 0.5680 3rd Quartile = -0.6314  
 Anti-Log Mean = 0.171 Anti-Log Std. Dev. : (-) 0.098  
 (+) 0.297

%	cum %	antilog	cls int	(# of bins = 14 - bin size = 0.0673)
0.00	2.27	0.074	-1.1306	
9.52	11.36	0.086	-1.0633	**
9.52	20.45	0.101	-0.9959	**
4.76	25.00	0.118	-0.9286	*
9.52	34.09	0.138	-0.8613	**
28.57	61.36	0.161	-0.7940	*****
4.76	65.91	0.188	-0.7267	*
0.00	65.91	0.219	-0.6594	
4.76	70.45	0.256	-0.5921	*
9.52	79.55	0.299	-0.5248	**
4.76	84.09	0.349	-0.4574	*
9.52	93.18	0.407	-0.3901	**
0.00	93.18	0.476	-0.3228	
0.00	93.18	0.555	-0.2555	
4.76	97.73	0.648	-0.1882	*

0 1 2 3 4

#####

19:39:44

05/09/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = H9

UNIT = HG/K

N = 21

N CI = 14

POPULATIONS

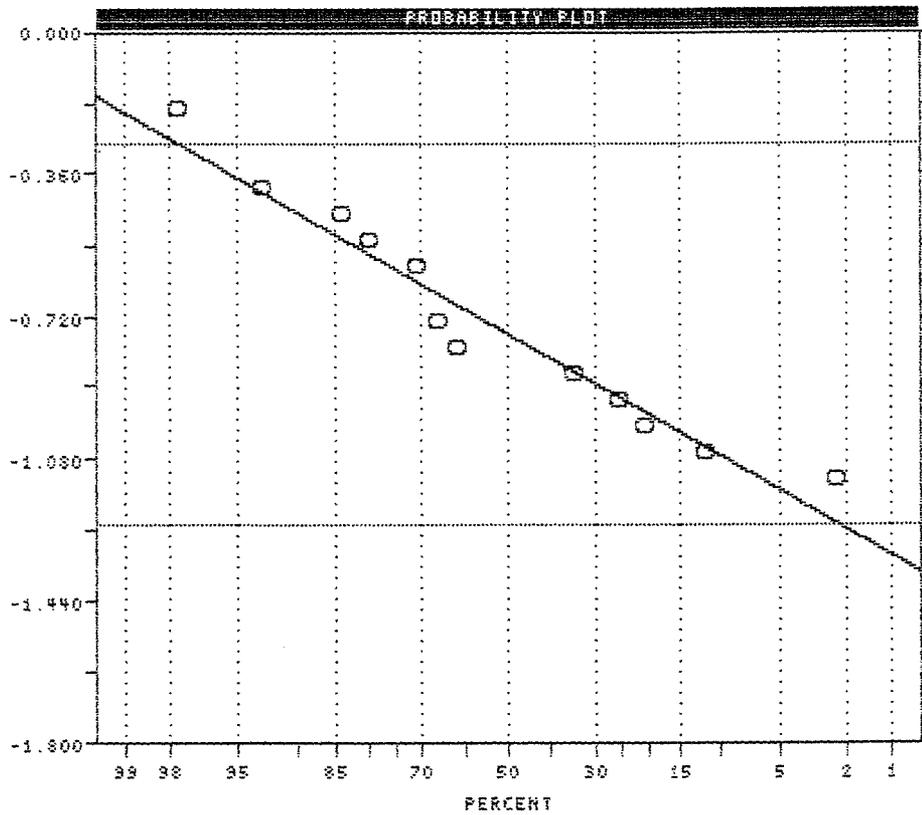
=====

Pop.	Mean	Std.Dev.	%
1	-0.7580	0.2409	100.0

POP. THRESHOLDS

Pop.	THRESHOLDS
1	-1.2498 -0.2863

RAW DATA ML  
PARAMETER ESTIMATES



#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = HG-1D.DAT

Variable = Hg Unit = MG/K N = 21  
N CI = 14

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 0.596

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.171	- 0.098 + 0.297	100.00

#####



09:52:30

RFP / DU-3

05/07/94

#####  
 SUMMARY STATISTICS and HISTOGRAM  
 LOGARITHMIC VALUES

Variable = Ni Unit = MG/K N = 41  
 Mean = 1.2033 Min = 0.7559 1st Quartile = 1.1273  
 Std. Dev. = 0.1744 Max = 1.8615 Median = 1.2214  
 CV % = 14.4904 Skewness = 0.6825 3rd Quartile = 1.2553  
 Anti-Log Mean = 15.969 Anti-Log Std. Dev. : (-) 10.688  
 (+) 23.858

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0691)
0.00	1.19	5.264	0.7213	
2.44	3.57	6.172	0.7904	*
2.44	5.95	7.237	0.8595	*
0.00	5.95	8.485	0.9286	
2.44	8.33	9.948	0.9977	*
7.32	15.48	11.664	1.0668	***
12.20	27.38	13.676	1.1359	*****
17.07	44.05	16.034	1.2050	*****
34.15	77.38	18.800	1.2742	*****
12.20	89.29	22.042	1.3433	*****
2.44	91.67	25.844	1.4124	*
4.88	96.43	30.301	1.4815	**
0.00	96.43	35.528	1.5506	
0.00	96.43	41.655	1.6197	
0.00	96.43	48.840	1.6888	
0.00	96.43	57.264	1.7579	
0.00	96.43	67.140	1.8270	
2.44	98.81	78.720	1.8961	*

#####

09:53:24  
05/07/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = HI  
UNIT = MG/K  
N = 41  
N CI = 17

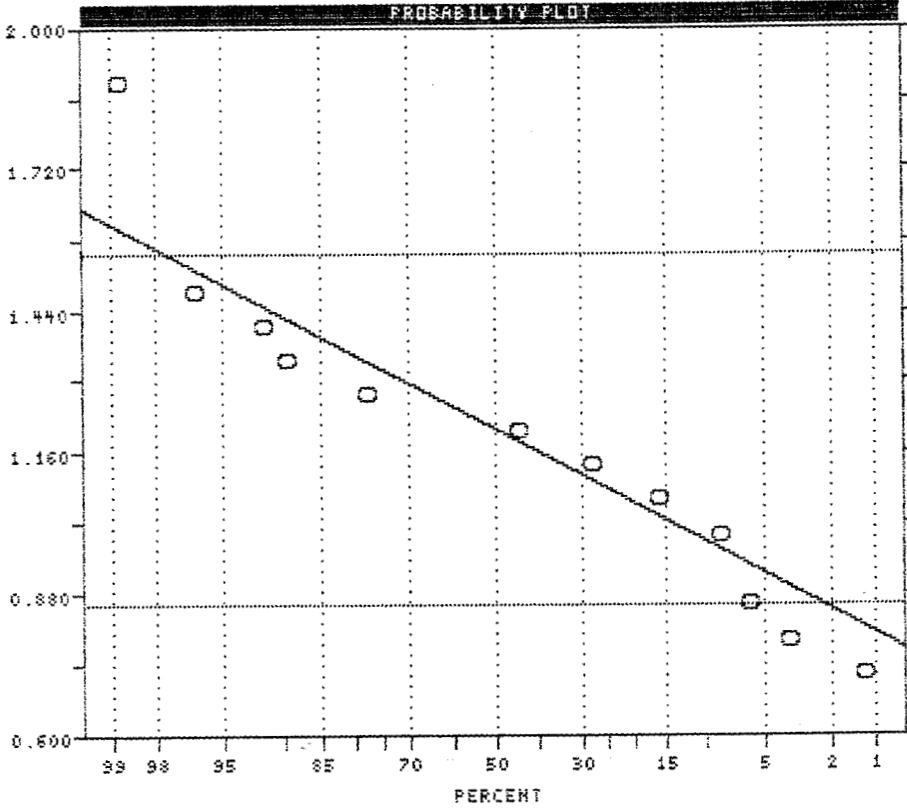
POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	1.2033	0.1744	100.0

THRESHOLDS

Pop.	Lower	Upper
1	0.8546	1.5520



RAW DATA ML  
PARAMETER ESTIMATES

09:54:41

RFP / OU-3

05/07/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = NI-OD.DAT

Variable = Ni Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 13.936

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	15.969	- 10.688 + 23.858	100.00

#####

17:53:38

RFP / OU-3

05/09/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Ni	Unit =	MG/K	N =	44
Mean =	1.0903	Min =	0.5315	1st Quartile =	0.9138
Std. Dev. =	0.2098	Max =	1.3655	Median =	1.1523
CV % =	19.2403	Skewness =	-0.5910	3rd Quartile =	1.2625
Anti-Log Mean =	12.311	Anti-Log Std. Dev. :	(-)	7.595	
			(+)	19.956	

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0521)
0.00	1.11	3.202	0.5054	
2.27	3.33	3.610	0.5575	*
0.00	3.33	4.071	0.6097	
0.00	3.33	4.590	0.6618	
0.00	3.33	5.175	0.7139	
4.55	7.78	5.835	0.7660	**
4.55	12.22	6.579	0.8182	**
2.27	14.44	7.418	0.8703	*
15.91	30.00	8.364	0.9224	*****
2.27	32.22	9.431	0.9745	*
4.55	36.67	10.633	1.0267	**
4.55	41.11	11.989	1.0788	**
6.82	47.78	13.518	1.1309	***
13.64	61.11	15.242	1.1830	*****
6.82	67.78	17.186	1.2352	***
9.09	76.67	19.378	1.2873	***
13.64	90.00	21.849	1.3394	*****
9.09	98.89	24.635	1.3916	***

0                    1                    2                    3                    4

#####

18:01:55  
05/03/84

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = NI  
UNIT = HG/K  
N = 44  
N CI = 17

POPULATIONS

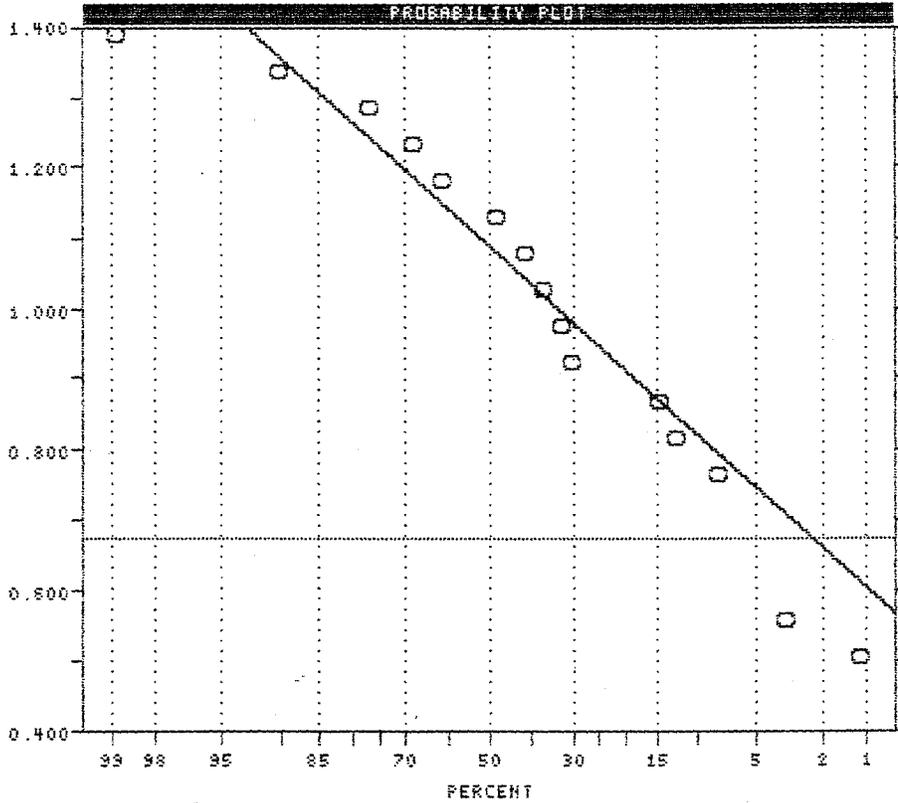
=====

Pop.	Mean	Std. Dev.	x
1	1.0903	0.2098	100.0

POP. THRESHOLDS

-----  
=====

1	0.6707	1.5089
---	--------	--------



RAW DATA ML  
PARAMETER ESTIMATES

18:03:05

RFP / OU-3

05/09/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = NI-ID.DAT

Variable = Ni Unit = MG/K N = 44  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 6.782

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	12.311	- 7.595 + 19.956	100.00

#####

15:45:25

RFP / DU-3: Ni-S

07/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM  
 LOGARITHMIC VALUES

Variable = Ni Unit = MG/K N = 15  
 Mean = 1.2307 Min = 1.0212 1st Quartile = 1.1739  
 Std. Dev. = 0.0948 Max = 1.4654 Median = 1.2416  
 CV % = 7.7055 Skewness = 0.2433 3rd Quartile = 1.2713  
 Anti-Log Mean = 17.008 Anti-Log Std. Dev. : (-) 13.672  
 (+) 21.158

%	cum %	antilog	cls int	(# of bins = 12 - bin size = 0.0404)
0.00	3.13	10.023	1.0010	
6.67	9.38	11.000	1.0414	*
0.00	9.38	12.071	1.0818	
0.00	9.38	13.248	1.1221	
6.67	15.63	14.539	1.1625	*
20.00	34.38	15.955	1.2029	***
13.33	46.88	17.510	1.2433	**
46.67	90.62	19.216	1.2837	*****
0.00	90.62	21.089	1.3240	
0.00	90.62	23.144	1.3644	
0.00	90.62	25.399	1.4048	
0.00	90.62	27.874	1.4452	
6.67	96.87	30.590	1.4856	*

#####

15:48:13  
07/08/34

RFP / DU-3: N1-5

LOGARITHMIC VALUES

=====

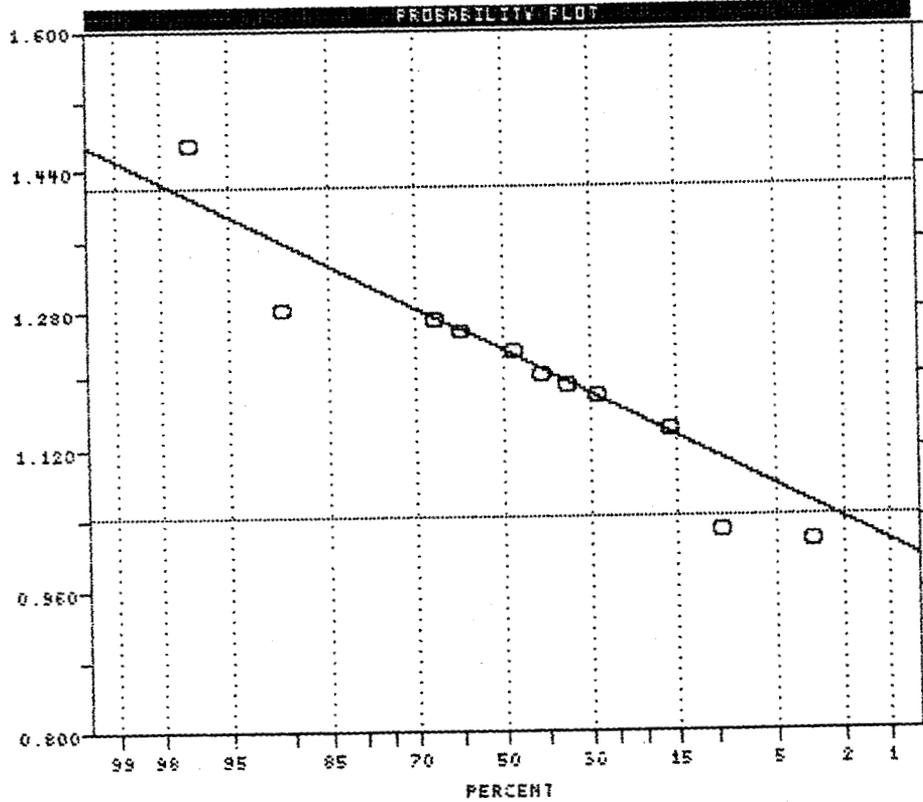
VARIABLE = N1  
UNIT = MG/K  
N = 15  
N CI = 36

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	1.2307	0.0998	100.0

Pop.	THRESHOLDS	
1	1.0410	1.4203



NEEDS VISUAL  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:NI-S.DAT

Variable = Ni Unit = MG/K N = 15  
N CI = 36

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Users Visual Parameter Estimates

Population	Mean	Std Dev	Percentage
1	17.008	- 13.672 + 21.158	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	10.990 26.321

#####

21:18:17

05/10/77

#####  
SUMMARY STATISTICS and HISTORRAM LOGARITHMIC VALUES

Variable = Si Unit = MG/K N = 23

Mean = 2.4066 Min = 2.0407 1st Quartile = 2.2049  
 Std. Dev. = 0.2636 Max = 3.0086 Median = 2.3439  
 CV % = 10.9543 Skewness = 1.0230 3rd Quartile = 2.4457

Anti-Log Mean = 255.013 Anti-Log Std. Dev. = (.1) 139.974  
 (.1) 447.935

```
=====
```

%	cum %	antilog	cls int	(# of bins = 14 - bin size = 0.0729)
0.00	2.08	105.740	2.0242	
4.35	6.25	125.071	2.0972	*
8.70	14.58	147.935	2.1701	**
17.39	31.25	174.979	2.2430	***
13.04	43.75	206.968	2.3159	***
17.39	60.42	244.804	2.3888	***
13.04	72.92	289.557	2.4617	***
4.35	77.08	342.491	2.5346	*
0.00	77.08	405.102	2.6076	
4.35	81.25	479.160	2.6805	*
4.35	85.42	566.755	2.7534	*
4.35	89.58	670.365	2.8263	*
0.00	89.58	792.915	2.8992	
0.00	89.58	937.869	2.9721	
8.70	97.92	1109.323	3.0451	**

-----  
0 1 2 3 4

#####

21:19:10  
05/06/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = S1  
UNIT = NS/K  
N = 23  
N CI = 14

POPULATIONS

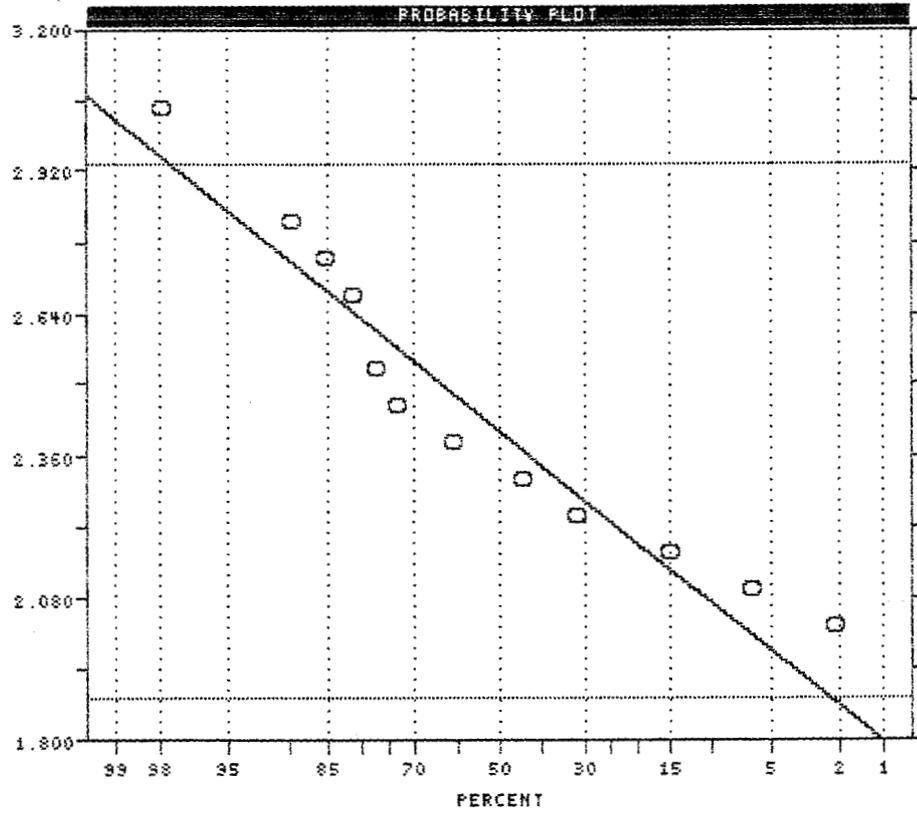
=====

Pop.	Mean	Std.Dev.	%
1	2.4066	0.2536	100.0

THRESHOLDS

-----

1	1.8793	2.9338
---	--------	--------



RAW DATA ML  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = SI-0D.DAT

Variable = Si Unit = MG/K N = 23  
N CI = 14

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -1.471

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	255.013	- 138.976 + 467.935	100.00

#####

16:47:38

RFP / OU-3

05/09/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Si Unit = MG/K N = 21

Mean = 2.5322 Min = 1.9138 1st Quartile = 2.2473  
 Std. Dev. = 0.4165 Max = 3.5172 Median = 2.3376  
 CV % = 16.4477 Skewness = 0.7183 3rd Quartile = 2.7998

Anti-Log Mean = 340.553 Anti-Log Std. Dev. : (-) 130.526  
 (+) 888.531

%	cum %	antilog	cls int	(# of bins = 14 - bin size = 0.1233)
0.00	2.27	71.145	1.8521	
4.76	6.82	94.511	1.9755	*
4.76	11.36	125.551	2.0988	*
4.76	15.91	166.785	2.2222	*
33.33	47.73	221.561	2.3455	*****
9.52	56.82	294.327	2.4688	**
4.76	61.36	390.992	2.5922	*
4.76	65.91	519.404	2.7155	*
9.52	75.00	689.989	2.8388	**
4.76	79.55	916.598	2.9622	*
9.52	88.64	1217.632	3.0855	**
4.76	93.18	1617.533	3.2089	*
0.00	93.18	2148.772	3.3322	
0.00	93.18	2854.482	3.4555	
4.76	97.73	3791.966	3.5789	*

0 1 2 3 4

#####

16:48:23  
05/09/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = S1  
UNIT = MG/K  
N = 21  
N CI = 14

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	2.5322	0.4165	100.0

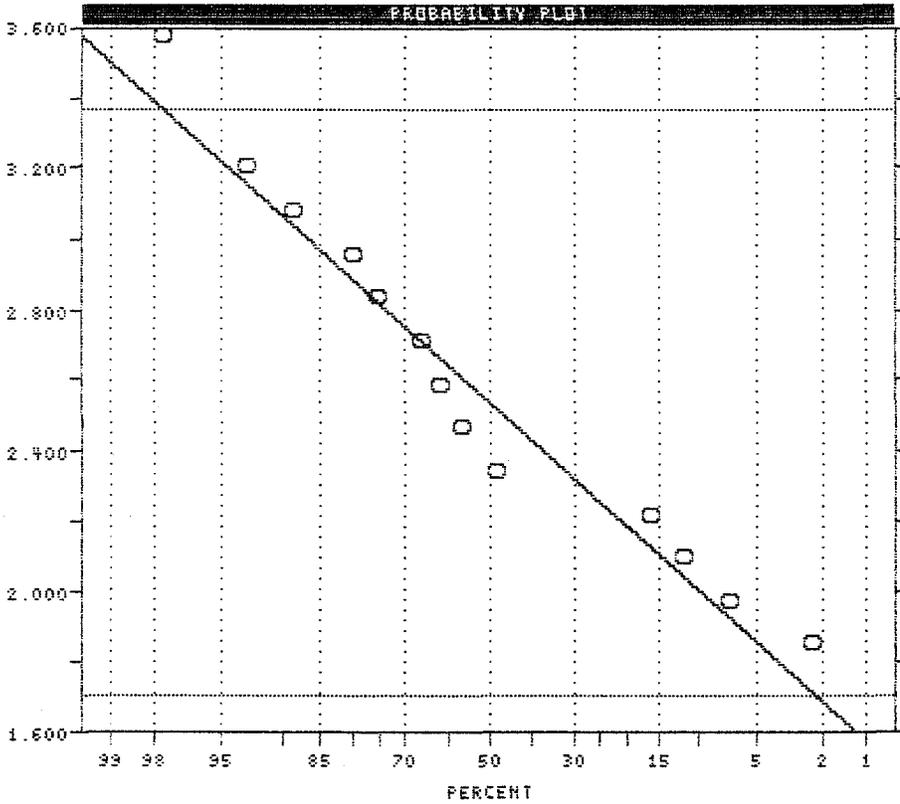
POP. THRESHOLDS

-----  
=====

1	1.6992	3.3652
---	--------	--------

RAW DATA ML

PARAMETER ESTIMATES



16:51:28

RFP / OU-3

05/09/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = SI-1D.DAT

Variable = Si Unit = MG/K N = 21  
N CI = 14

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

\*\*\*\*\*

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -10.904

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	340.553	- 130.526 + 888.531	100.00

\*\*\*\*\*

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Zn Unit = MG/K N = 41

Mean = 2.1392 Min = 1.4548 1st Quartile = 1.9013  
 Std. Dev. = 0.3225 Max = 2.6955 Median = 2.0810  
 CV % = 15.0759 Skewness = 0.1857 3rd Quartile = 2.3737

Anti-Log Mean = 137.798 Anti-Log Std. Dev. : (-) 65.574  
 (+) 289.568

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0775)
0.00	1.19	26.066	1.4161	
2.44	3.57	31.161	1.4936	*
0.00	3.57	37.252	1.5712	
2.44	5.95	44.534	1.6487	*
2.44	8.33	53.240	1.7262	*
2.44	10.71	63.646	1.8038	*
9.76	20.24	76.088	1.8813	****
12.20	32.14	90.961	1.9589	*****
9.76	41.67	108.741	2.0364	****
14.63	55.95	129.997	2.1139	*****
7.32	63.10	155.408	2.1915	***
4.88	67.86	185.786	2.2690	**
2.44	70.24	222.102	2.3466	*
4.88	75.00	265.517	2.4241	**
4.88	79.76	317.418	2.5016	**
4.88	84.52	379.465	2.5792	**
7.32	91.67	453.640	2.6567	***
7.32	98.81	542.315	2.7343	***

0 1 2 3 4

#####

15:13:30  
05/05/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = 2n  
UNIT = KG/K  
N = 41  
N CI = 17

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	2.1392	0.3225	100.0

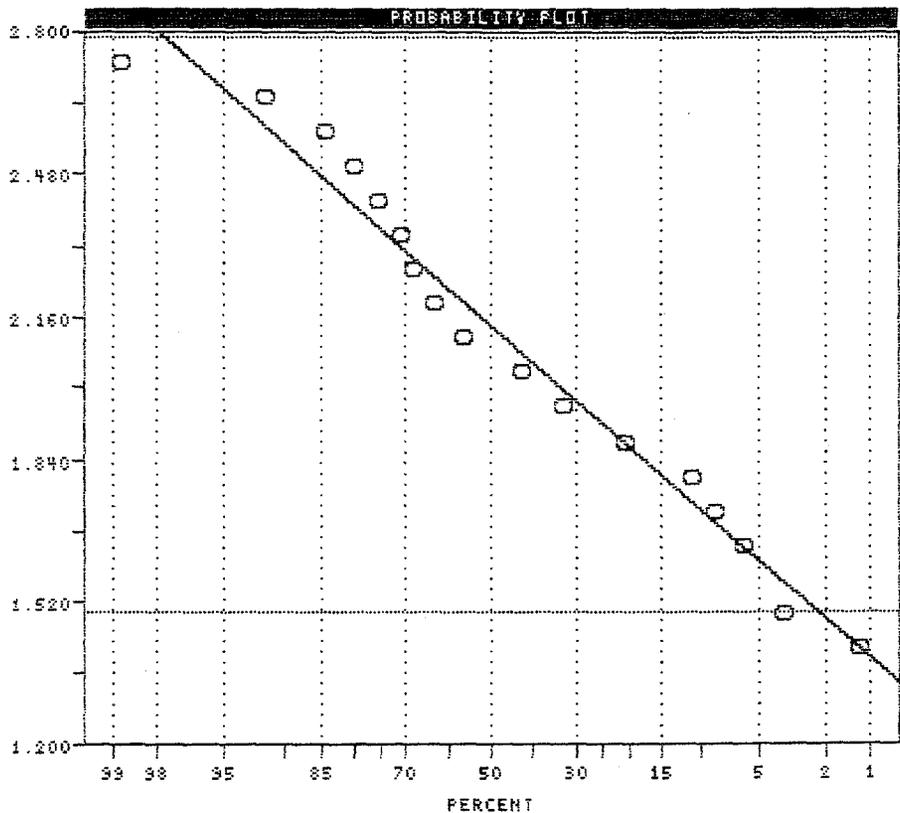
POP. THRESHOLDS

-----  
=====

1	1.4942	2.7843
---	--------	--------

RAW DATA ML

PARAMETER ESTIMATES



\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = ZN-0D.DAT

Variable = Zn Unit = MG/K N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -11.280

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	137.798	- 65.574 + 289.568	100.00

\*\*\*\*\*

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Zn Unit = MG/K N = 47

Mean = 2.2599 Min = 0.9542 1st Quartile = 1.7324  
 Std. Dev. = 0.6356 Max = 3.0682 Median = 2.2657  
 CV % = 28.1239 Skewness = -0.2617 3rd Quartile = 2.8719

Anti-Log Mean = 181.931 Anti-Log Std. Dev. : (-) 42.105  
 (+) 786.107

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.1321)
0.00	1.04	7.730	0.8882	
2.13	3.13	10.479	1.0203	*
2.13	5.21	14.204	1.1524	*
0.00	5.21	19.255	1.2845	
6.38	11.46	26.102	1.4167	***
6.38	17.71	35.383	1.5488	***
2.13	19.79	47.963	1.6809	*
10.64	30.21	65.018	1.8130	*****
8.51	38.54	88.136	1.9452	*****
6.38	44.79	119.474	2.0773	***
2.13	46.88	161.956	2.2094	*
6.38	53.13	219.542	2.3415	***
2.13	55.21	297.604	2.4736	*
2.13	57.29	403.423	2.6058	*
6.38	63.54	546.868	2.7379	***
8.51	71.88	741.317	2.8700	*****
21.28	92.71	1004.905	3.0021	*****
6.38	98.96	1362.218	3.1342	***

0 1 2 3 4

#####

13:50:01  
05/06/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = Zn

UNIT = HG/K

N = 47

N CI = 17

POPULATIONS

=====

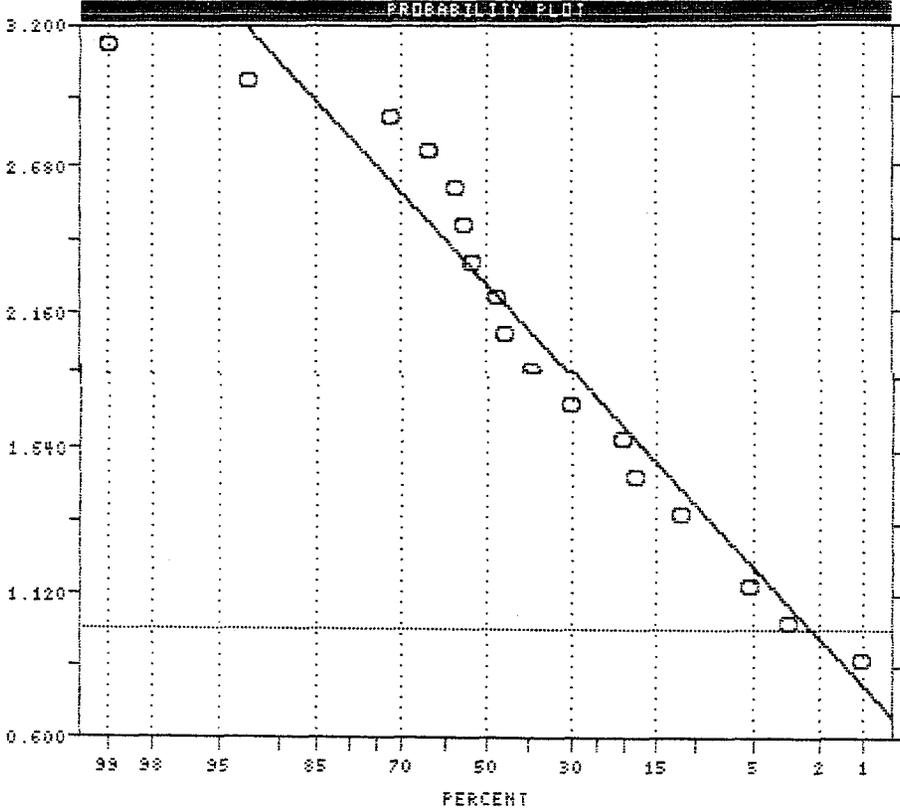
Pop.	Mean	Std.Dev.	%
1	2.2539	0.6356	100.0

POP. THRESHOLDS

Pop.	Lower	Upper
1	0.9888	3.5311

RAW DATA ML

PARAMETER ESTIMATES



#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = ZN-1D.DAT

Variable = Zn Unit = MG/K N = 47  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -44.889

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	181.931	- 42.105 + 786.107	100.00

#####

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUEE

Variable = Zn Unit = MG/K N = 19

Mean = 1.8422 Min = 1.6075 1st Quartile = 1.6753  
 Std. Dev. = 0.1575 Max = 2.2856 Median = 1.8364  
 CV % = 8.5519 Skewness = 0.8498 3rd Quartile = 1.9289

Anti-Log Mean = 69.540 Anti-Log Std. Dev. : (-) 48.383  
 (+) 99.950

=====					
%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0565)	
-----					
0.00	2.50	37.949	1.5792		
5.26	7.50	43.222	1.6357	*	
15.79	22.50	49.229	1.6922	***	
5.26	27.50	56.069	1.7487	*	
10.53	37.50	63.861	1.8052	**	
15.79	52.50	72.735	1.8617	***	
21.05	72.50	82.842	1.9183	****	
15.79	87.50	94.354	1.9748	***	
5.26	92.50	107.465	2.0313	*	
0.00	92.50	122.399	2.0878		
0.00	92.50	139.407	2.1443		
0.00	92.50	158.780	2.2008		
0.00	92.50	180.844	2.2573		
5.26	97.50	205.974	2.3138	*	
-----					
			0	1	2 3 4

#####

11:52:57

05/03/94

RFP / DU-3: Zn-S

LOGARITHMIC VALUES

=====

VARIABLE = Zn

UNIT = MG/K

N = 19

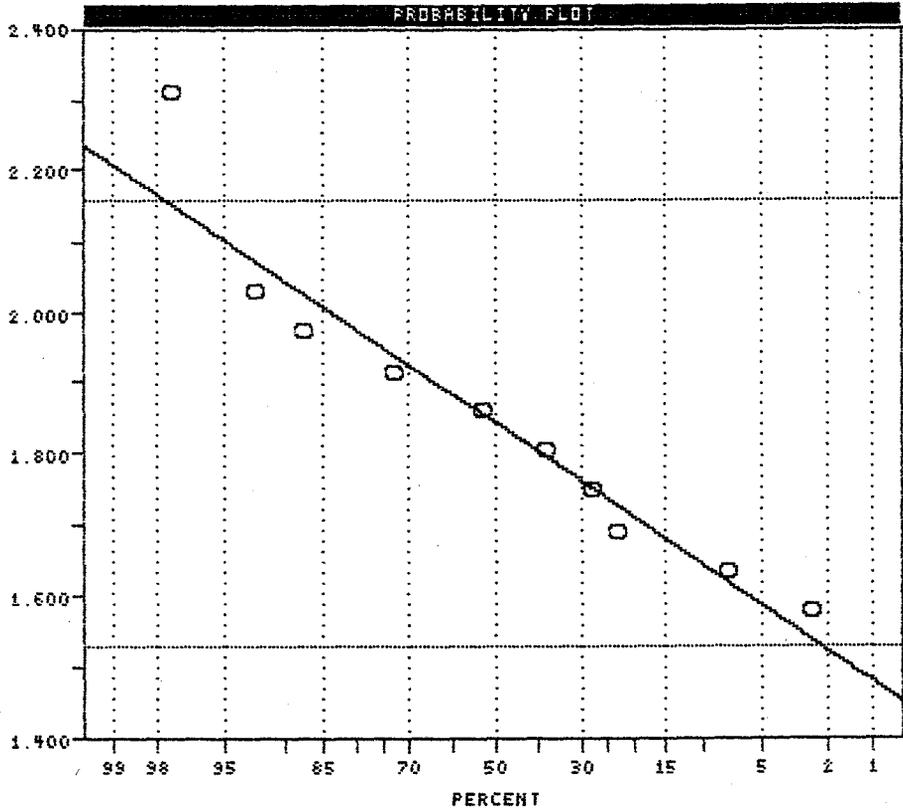
N CI = 13

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	1.8422	0.1575	100.0

Pop.	THRESHOLDS	
1	1.5271	2.1573



RAW DATA HL  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:ZN-S.DAT

Variable = Zn Unit = MG/K N = 19  
N CI = 13

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 8.653

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	69.540	- 48.383 + 99.950	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	33.662 143.658

#####

09:18:16

RFP / OU-3

05/07/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Pu239 Unit = PCI/ N = 89

Mean = -1.0729 Min = -2.6990 1st Quartile = -1.6021  
 Std. Dev. = 0.6705 Max = 0.5185 Median = -1.0000  
 CV % = 62.4948 Skewness = -0.0728 3rd Quartile = -0.6555

Anti-Log Mean = 0.085 Anti-Log Std. Dev. : (-) 0.018  
 (+) 0.396

```
=====
```

%	cum %	antilog	cls int	(# of bins = 20 - bin size = 0.1693)
0.00	0.56	0.002	-2.7836	
2.25	2.78	0.002	-2.6143	**
0.00	2.78	0.004	-2.4450	
3.37	6.11	0.005	-2.2756	***
1.12	7.22	0.008	-2.1063	*
3.37	10.56	0.012	-1.9369	***
3.37	13.89	0.017	-1.7676	***
12.36	26.11	0.025	-1.5983	*****
1.12	27.22	0.037	-1.4289	*
7.87	35.00	0.055	-1.2596	*****
12.36	47.22	0.081	-1.0902	*****
8.99	56.11	0.120	-0.9209	*****
14.61	70.56	0.177	-0.7515	*****
6.74	77.22	0.262	-0.5822	*****
7.87	85.00	0.386	-0.4129	*****
5.62	90.56	0.571	-0.2435	*****
3.37	93.89	0.843	-0.0742	***
2.25	96.11	1.245	0.0952	**
0.00	96.11	1.839	0.2645	
0.00	96.11	2.715	0.4338	
3.37	99.44	4.010	0.6032	***

```
=====
```

0 1 2 3 4

#####

09:21:42  
05/07/94

RFP / DU-3

LOGARITHMIC VALUES

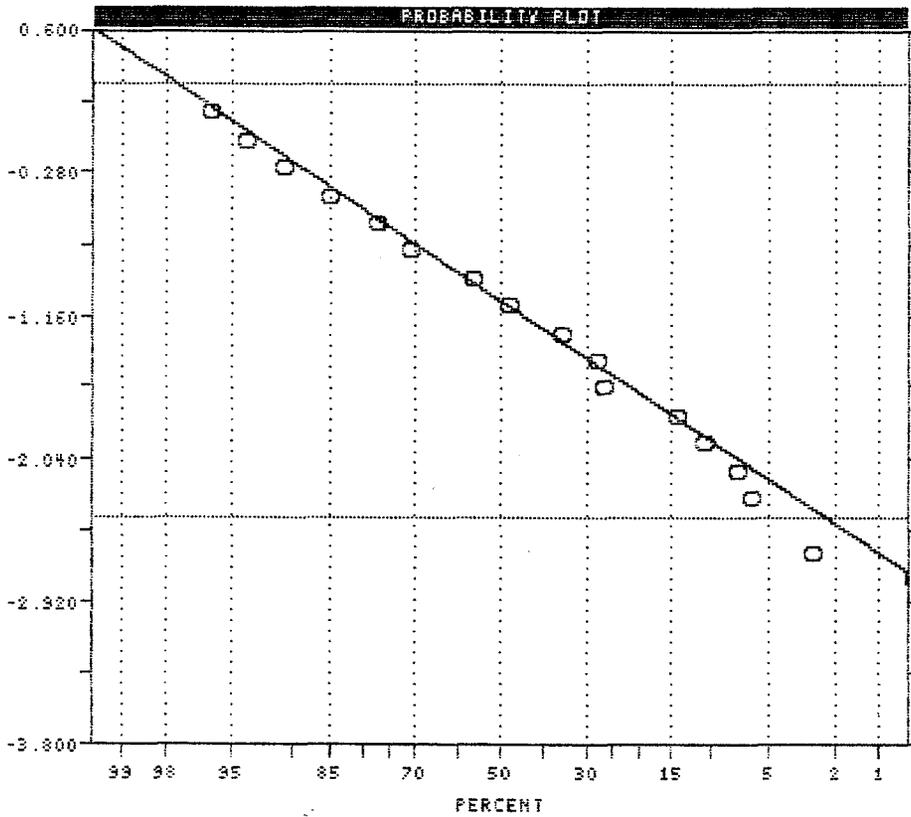
VARIABLE = PU233  
UNIT = PCI/  
N = 89  
N CI = 20

POPULATIONS

Pop.	Mean	Std.Dev.	%
1	-1.0723	0.6705	100.0

THRESHOLDS

Pop.	Mean	Std.Dev.
1	-2.4139	0.2681



RAW DATA ML  
PARAMETER ESTIMATES



17:07:50

RFP / OU-3

05/09/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Pu239	Unit =	PCI/	N =	94
Mean =	-1.6421	Min =	-2.9508	1st Quartile =	-1.9127
Std. Dev. =	0.5372	Max =	-0.2573	Median =	-1.5850
CV % =	32.7134	Skewness =	-0.1105	3rd Quartile =	-1.3099
Anti-Log Mean =	0.023	Anti-Log Std. Dev. :	(-)	0.007	
			(+)	0.079	

%	cum %	antilog	cls int	(# of bins = 20 - bin size = 0.1418)
0.00	0.53	0.001	-3.0217	
2.13	2.63	0.001	-2.8799	**
0.00	2.63	0.002	-2.7381	
3.19	5.79	0.003	-2.5964	***
4.26	10.00	0.004	-2.4546	****
0.00	10.00	0.005	-2.3128	
9.57	19.47	0.007	-2.1711	*****
2.13	21.58	0.009	-2.0293	**
4.26	25.79	0.013	-1.8876	****
9.57	35.26	0.018	-1.7458	*****
13.83	48.95	0.025	-1.6040	*****
14.89	63.68	0.034	-1.4623	*****
9.57	73.14	0.048	-1.3205	*****
9.57	82.63	0.066	-1.1787	*****
8.51	91.05	0.092	-1.0370	*****
2.13	93.16	0.127	-0.8952	**
1.06	94.21	0.176	-0.7534	*
2.13	96.32	0.245	-0.6117	**
0.00	96.32	0.339	-0.4699	
1.06	97.37	0.470	-0.3282	*
2.13	99.47	0.651	-0.1864	**

0 1 2 3 4

#####

17:08:46  
05/09/94

RFP / DU-3

LOGARITHMIC VALUES

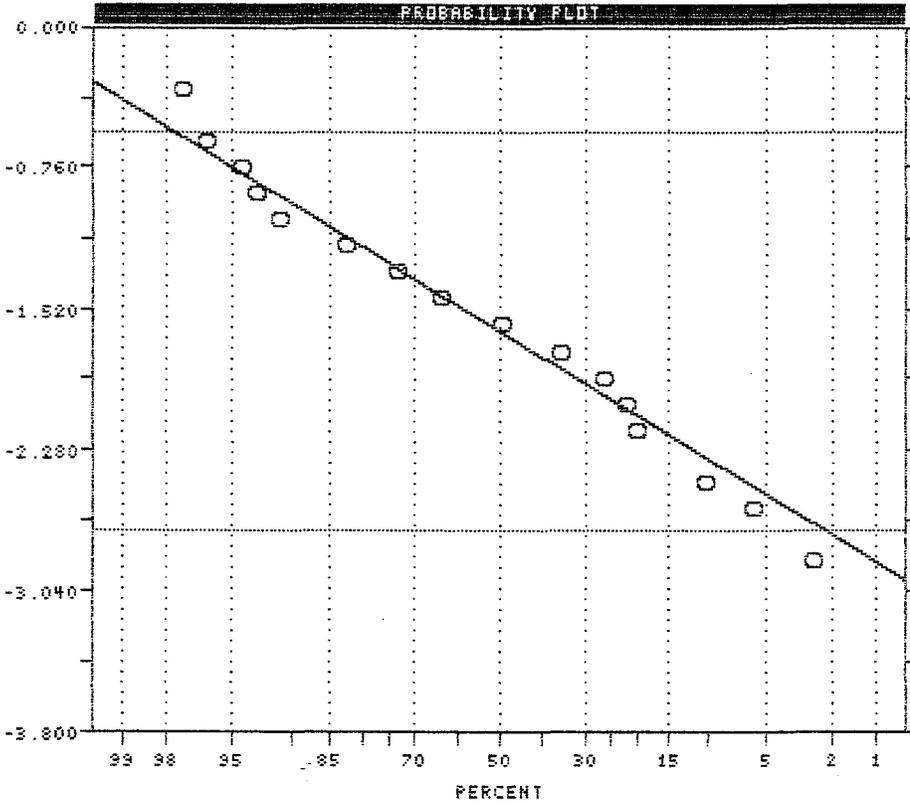
VARIABLE = PU239  
UNIT = PCI/  
N = 94  
N CI = 20

POPULATIONS

Pop.	Mean	Std.Dev.	%
1	-1.6421	0.5372	100.0

THRESHOLDS

1	-2.7165	-0.5677
---	---------	---------



RAW DATA HL  
PARAMETER ESTIMATES

17:09:49

RFP / OU-3

05/09/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = PU239-1D.DAT

Variable = Pu239 Unit = PCI/ N = 94  
N CI = 20

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 7.

S Observations Were Below the Minimum Value of 0.0001  
O Observations Were Above the Maximum Value of 99999.9999

\*\*\*\*\*

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -74.467

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.023	- 0.007 + 0.079	100.00

\*\*\*\*\*

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUE  
 #####

Variable = Pu239 Unit = PCI/ N = 19

Mean = -0.7639 Min = -1.5086 1st Quartile = -1.2932

Std. Dev. = 0.4395 Max = -0.3117 Median = -0.6002

CV % = 57.5324 Skewness = -0.5896 3rd Quartile = -0.4014

Anti-Log Mean = 0.172 Anti-Log Std. Dev. : (-) 0.063  
 (+) 0.474

```
=====
```

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0997)
0.00	2.50	0.028	-1.5585	
10.53	12.50	0.035	-1.4588	**
5.26	17.50	0.044	-1.3590	*
5.26	22.50	0.055	-1.2593	*
5.26	27.50	0.069	-1.1595	*
5.26	32.50	0.087	-1.0598	*
0.00	32.50	0.110	-0.9600	
5.26	37.50	0.138	-0.8603	*
5.26	42.50	0.174	-0.7605	*
0.00	42.50	0.218	-0.6608	
10.53	52.50	0.275	-0.5610	**
5.26	57.50	0.346	-0.4613	*
26.32	82.50	0.435	-0.3615	*****
15.79	97.50	0.547	-0.2618	***

```
-----
```

0                    1                    2                    3

#####

11:33:59  
05/03/94

RFP / DU-3: Pu239-S

LOGARITHMIC VALUES

=====

VARIABLE = Pu239  
UNIT = PCI/  
N = 19  
N CI = 13

POPULATIONS

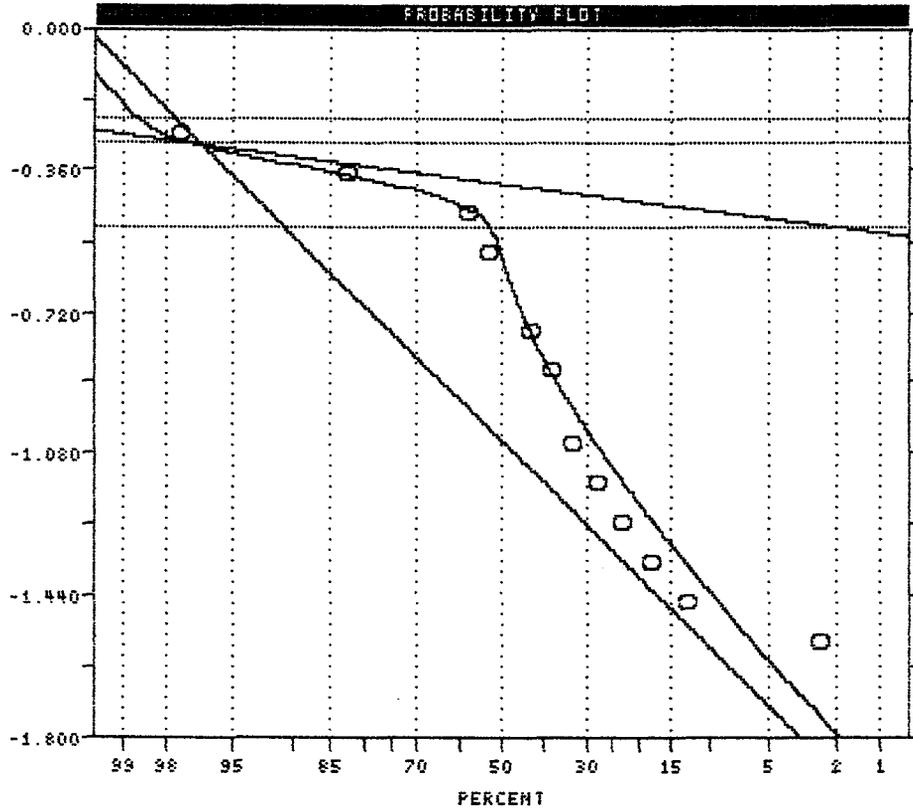
=====

Pop.	Mean	Std.Dev.	%
1	-1.0490	0.4103	56.4
2	-0.3967	0.0521	43.6

POP. THRESHOLDS

-----

Pop.	Mean	Std.Dev.
1	-1.8696	-0.2285
2	-0.5009	-0.2925



RAW DATA NL  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:PU239-S.DAT

Variable = Pu239 Unit = FCI/ N = 19  
N CI = 13

Transform = Logarithmic Number of Populations = 2

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -3.105

Parameterized Degrees of Freedom = 3

Population	Mean	Std Dev	Percentage
1	0.089	- 0.035 + 0.230	56.40
2	0.401	- 0.356 + 0.452	43.60

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	0.014 0.591
2	0.316 0.510

#####

21:43:50

RFP / DU-3

05/06/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable = Ra226 Unit = FCI/ N = 20

Mean = 0.0330 Min = -0.0757 1st Quartile = -0.0269  
 Std. Dev. = 0.0935 Max = 0.3424 Median = 0.0000  
 CV % = 282.9197 Skewness = 1.7425 3rd Quartile = 0.0792

Anti-Log Mean = 1.079 Anti-Log Std. Dev. : (-) 0.870  
 (+) 1.338

=====

%	cum %	antilog	cls int	(# of bins = 14 - bin size = 0.0322)
0.00	2.38	0.809	-0.0918	
10.00	11.90	0.872	-0.0596	**
15.00	26.19	0.939	-0.0275	***
30.00	54.76	1.011	0.0047	*****
0.00	54.76	1.089	0.0369	
10.00	64.29	1.172	0.0690	**
20.00	83.33	1.262	0.1012	***
10.00	92.86	1.359	0.1334	**
0.00	92.86	1.464	0.1655	
0.00	92.86	1.576	0.1977	
0.00	92.86	1.698	0.2298	
0.00	92.86	1.828	0.2620	
0.00	92.86	1.969	0.2942	
0.00	92.86	2.120	0.3263	
5.00	97.62	2.283	0.3585	*

-----

0            1            2            3            4

#####

21:44:38  
05/05/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = R226

UNIT = PCI/

N = 20

N CI = 14

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.0330	0.0335	100.0

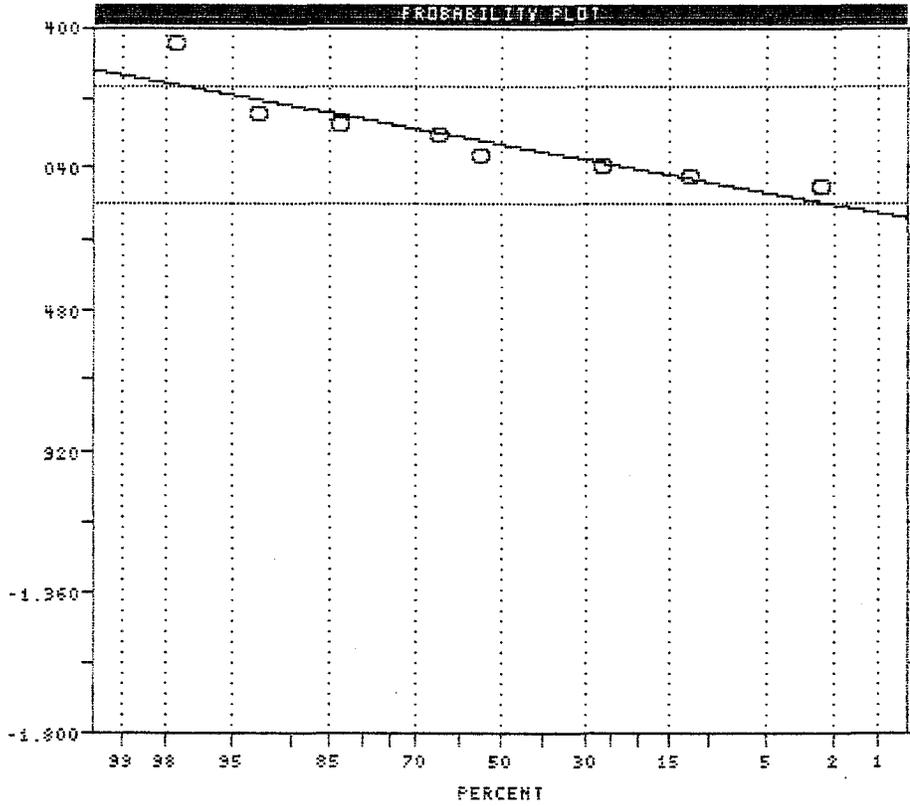
POP. THRESHOLDS

-----

Pop.	Mean	Std.Dev.
1	-0.1540	0.2201

RAW DATA ML

PARAMETER ESTIMATES



21:45:49

RFP / OU-3

05/06/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = RA226-0D.DAT

Variable = Ra226 Unit = FCI/ N = 20  
N CI = 14

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 19.516

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	1.079	0.870	100.00
		1.338	

#####

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = U233 Unit = PCI/ N = 39  
 Mean = 0.0961 Min = -0.1308 1st Quartile = -0.0359  
 Std. Dev. = 0.1744 Max = 0.7324 Median = 0.0792  
 CV % = 181.4570 Skewness = 1.3483 3rd Quartile = 0.1759  
 Anti-Log Mean = 1.248 Anti-Log Std. Dev. : (-) 0.835  
 (+) 1.864

```
=====
```

%	cum %	antilog	cls int	(# of bins = 16 - bin size = 0.0575)
0.00	1.25	0.693	-0.1595	
5.13	6.25	0.791	-0.1020	**
15.38	21.25	0.903	-0.0445	*****
17.95	38.75	1.031	0.0131	*****
5.13	43.75	1.177	0.0706	**
20.51	63.75	1.343	0.1282	*****
15.38	78.75	1.534	0.1857	*****
5.13	83.75	1.751	0.2433	**
5.13	88.75	1.999	0.3008	**
2.56	91.25	2.282	0.3584	*
2.56	93.75	2.606	0.4159	*
2.56	96.25	2.975	0.4734	*
0.00	96.25	3.396	0.5310	
0.00	96.25	3.877	0.5885	
0.00	96.25	4.427	0.6461	
0.00	96.25	5.054	0.7036	
2.56	98.75	5.770	0.7612	*

```
-----
```

0            1            2            3            4

#####

20:38:30  
05/06/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = U233  
UNIT = PCI/  
N = 39  
N CI = 16

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	0.0961	0.1744	100.0

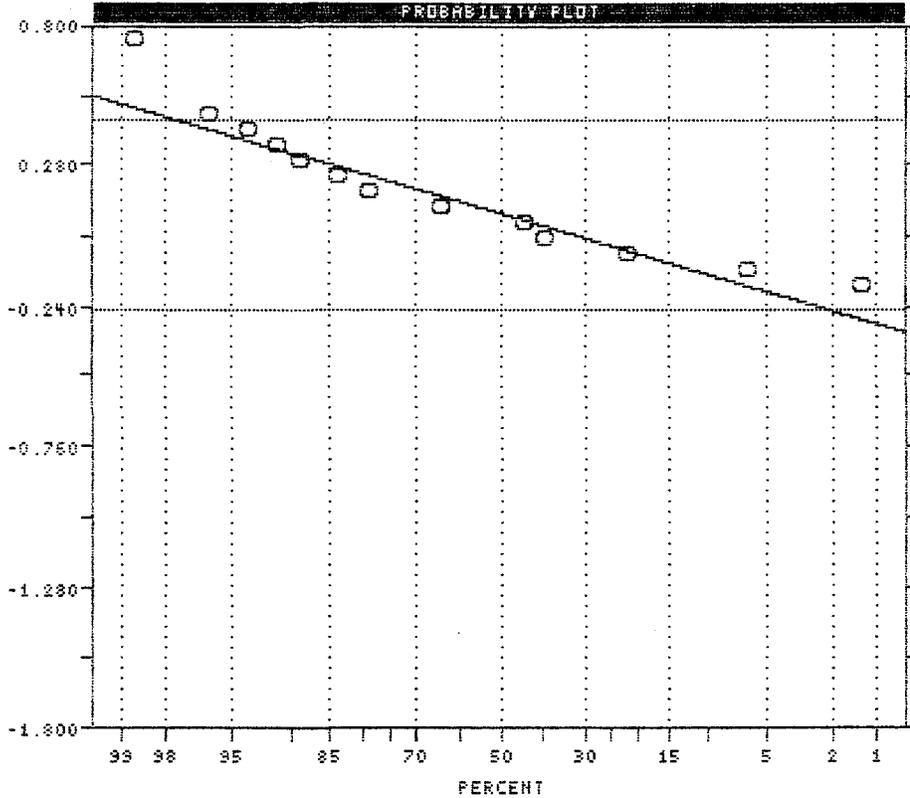
THRESHOLDS

-----  
=====

1	-0.2527	0.4450
---	---------	--------

RAW DATA ML

PARAMETER ESTIMATES



#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = U233-0D.DAT

Variable = U233 Unit = PCI/ N = 39  
N CI = 16

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = 13.266

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	1.248	0.835	100.00
		1.864	

#####

21:04:33

RFP / 00-3

05/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	U233	Unit =	PCI/	N =	45
Mean =	0.0523	Min =	-0.5376	1st Quartile =	-0.1301
Std. Dev. =	0.2582	Max =	0.6721	Median =	0.0831
CV % =	493.6132	Skewness =	-0.2030	3rd Quartile =	0.2304
Anti-Log Mean =	1.128	Anti-Log Std. Dev. :	(-)	0.622	
			(+)	2.044	

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0756)
0.00	1.09	0.266	-0.5754	
2.22	3.26	0.316	-0.4998	*
2.22	5.43	0.377	-0.4242	*
0.00	5.43	0.448	-0.3486	
6.67	11.96	0.533	-0.2730	***
8.89	20.65	0.635	-0.1974	****
6.67	27.17	0.755	-0.1218	***
11.11	38.04	0.899	-0.0462	*****
2.22	40.22	1.070	0.0294	*
11.11	51.09	1.274	0.1051	*****
13.33	64.13	1.516	0.1807	*****
15.56	79.35	1.804	0.2563	*****
8.89	88.04	2.147	0.3319	****
4.44	92.39	2.556	0.4075	**
4.44	96.74	3.041	0.4831	**
0.00	96.74	3.620	0.5587	
0.00	96.74	4.308	0.6343	
2.22	98.91	5.127	0.7099	*

0                    1                    2                    3                    4

#####

21:06:02

05/08/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = U233

UNIT = PCI/

N = 45

N CI = 17

POPULATIONS

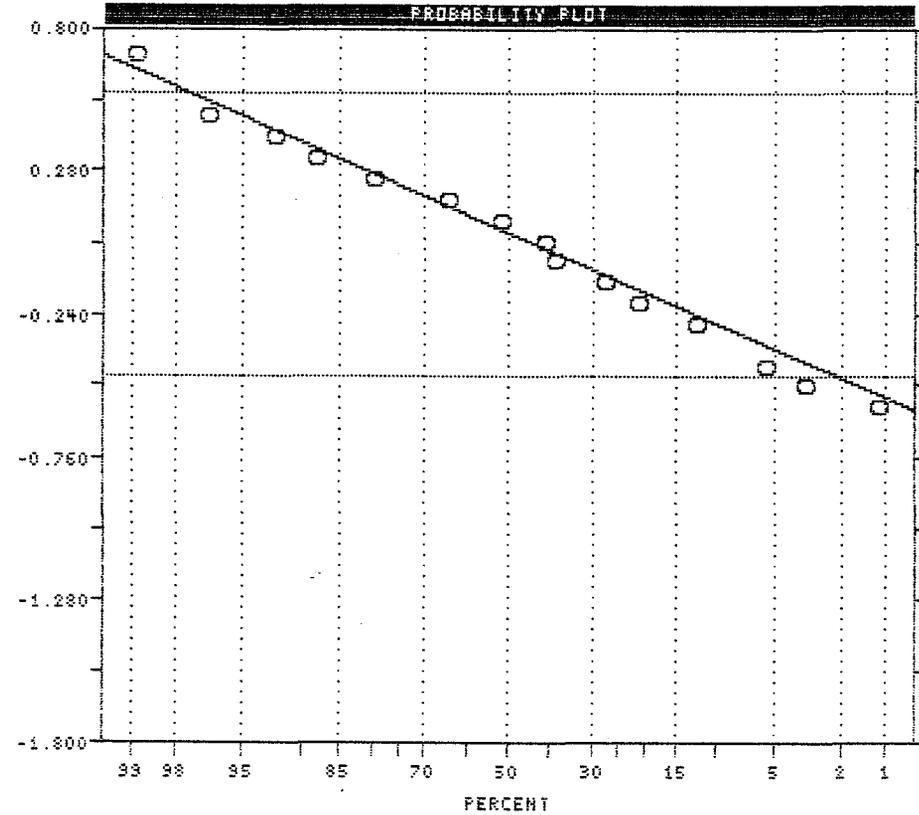
=====

Pop.	Mean	Std.Dev.	x
1	0.0523	0.2582	100.0

Pop.	THRESHOLDS	
1	-0.4841	0.5688

RAW DATA ML

PARAMETER ESTIMATES



21:07:07

RFP / OU-3

05/08/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = U233-1D.DAT

Variable = U233 Unit = PCI/ N = 45  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -2.427

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	1.128	- 0.622 + 2.044	100.00

\*\*\*\*\*

15:50:31

RFP / DU-3: U233-S

07/08/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = U233 Unit = PCI/ N = 19

Mean = 0.1122 Min = -0.1805 1st Quartile = -0.0042

Std. Dev. = 0.1519 Max = 0.5441 Median = 0.0930

CV % = 135.4429 Skewness = 0.9329 3rd Quartile = 0.1850

Anti-Log Mean = 1.295 Anti-Log Std. Dev. : (-) 0.913  
(+) 1.837

```
=====
```

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0604)
0.00	2.50	0.616	-0.2106	
5.26	7.50	0.708	-0.1503	*
0.00	7.50	0.813	-0.0899	
0.00	7.50	0.934	-0.0295	
21.05	27.50	1.074	0.0309	****
21.05	47.50	1.234	0.0912	****
26.32	72.50	1.418	0.1516	*****
15.79	87.50	1.629	0.2120	***
0.00	87.50	1.872	0.2724	
5.26	92.50	2.152	0.3327	*
0.00	92.50	2.472	0.3931	
0.00	92.50	2.841	0.4535	
0.00	92.50	3.265	0.5139	
5.26	97.50	3.752	0.5743	*

0 1 2 3

#####

15:51:47  
07/08/94

RFP / DU-3: U233-S

LOGARITHMIC VALUES

=====

VARIABLE = U233  
UNIT = PCI/  
N = 19  
N CI = 36

POPULATIONS

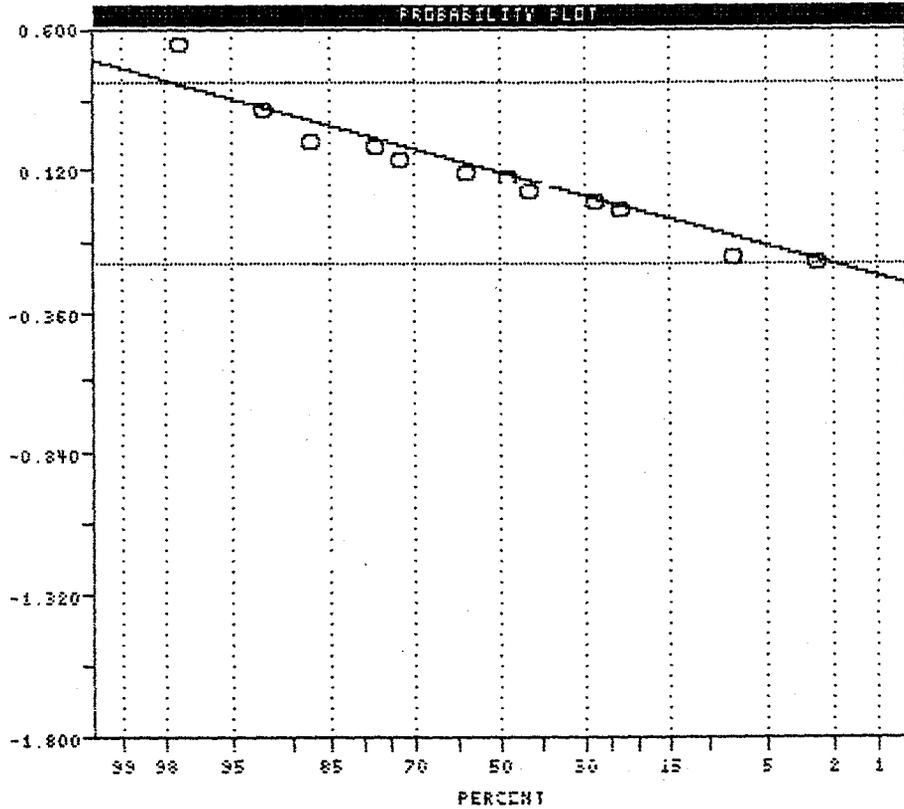
=====

Pop.	Mean	Std.Dev.	%
1	0.1122	0.1519	100.0

THRESHOLDS

=====

1	-0.1917	0.4160
---	---------	--------



USERS VISUAL  
PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:U233-S.DAT

Variable = U233 Unit = PCI/ N = 19  
N CI = 36

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Users Visual Parameter Estimates

Population	Mean	Std Dev	Percentage
1	1.295 - +	0.913 1.837	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	0.643 2.606

#####

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = U235 Unit = PCI/ N = 38

Mean = -1.2687 Min = -2.1079 1st Quartile = -1.4536  
Std. Dev. = 0.3427 Max = -0.2518 Median = -1.2366  
CV % = 27.0106 Skewness = 0.1314 3rd Quartile = -1.0833

Anti-Log Mean = 0.054 Anti-Log Std. Dev. : (-) 0.024  
(+) 0.119

%	cum %	antilog	cls int	(# of bins = 16 - bin size = 0.1237)
0.00	1.28	0.007	-2.1698	
2.63	3.85	0.009	-2.0460	*
0.00	3.85	0.012	-1.9223	
7.89	11.54	0.016	-1.7986	***
0.00	11.54	0.021	-1.6748	
5.26	16.67	0.028	-1.5511	**
10.53	26.92	0.037	-1.4273	****
15.79	42.31	0.050	-1.3036	*****
26.32	67.95	0.066	-1.1799	*****
7.89	75.64	0.088	-1.0561	***
15.79	91.03	0.117	-0.9324	*****
0.00	91.03	0.155	-0.8086	
5.26	96.15	0.207	-0.6849	**
0.00	96.15	0.275	-0.5612	
0.00	96.15	0.365	-0.4374	
0.00	96.15	0.486	-0.3137	
2.63	98.72	0.646	-0.1899	*

0 1 2 3 4

#####

20:31:57  
05/06/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = U235  
UNIT = PCI/  
N = 38  
N CI = 16

POPULATIONS

=====

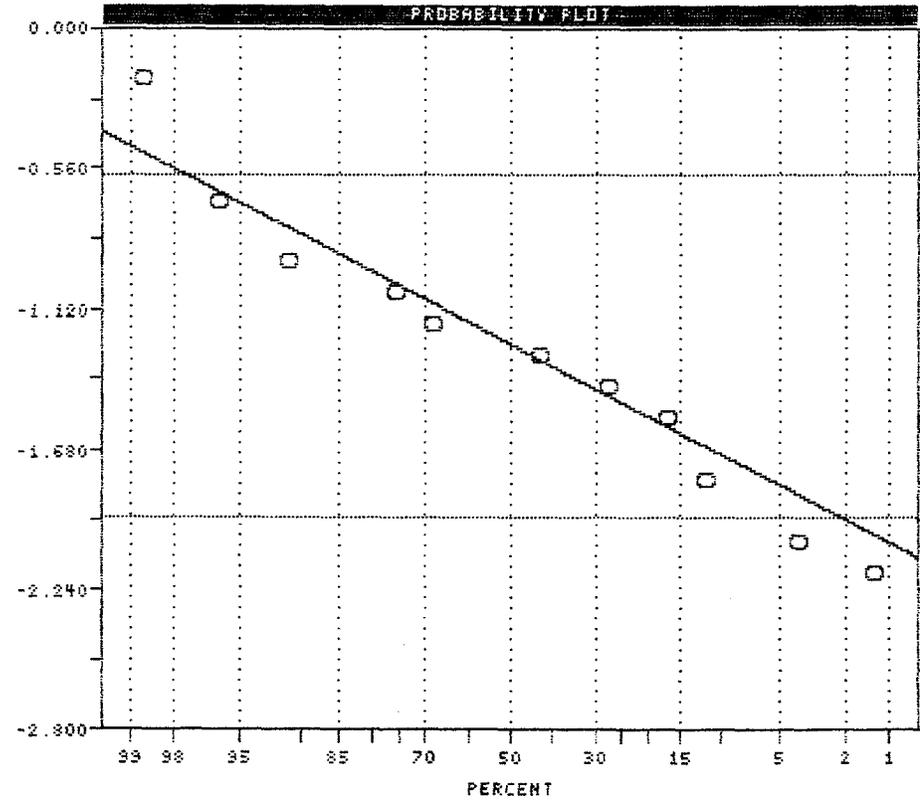
Pop.	Mean	Std.Dev.	%
1	-1.2687	0.3427	100.0

Pop. THRESHOLDS

-----  
=====

1	-1.3541	-0.5833
---	---------	---------

RAW DATA ML  
PARAMETER ESTIMATES



#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = U235-OD.DAT

Variable = U235 Unit = FCI/ N = 38  
N CI = 16

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 1.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -12.724

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.054	0.024 + 0.119	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	0.011 0.261

#####

20:53:23

RFP / OU-3

05/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	U235	Unit =	PCI/	N =	41
Mean =	-1.3185	Min =	-2.0809	1st Quartile =	-1.4619
Std. Dev. =	0.3207	Max =	-0.6990	Median =	-1.2500
CV % =	24.3220	Skewness =	-0.7418	3rd Quartile =	-1.1205
Anti-Log Mean =	0.048	Anti-Log Std. Dev. :	(-)	0.023	
			(+)	0.100	

%	cum %	antilog	cls int	(# of bins = 17 - bin size = 0.0864)
0.00	1.19	0.008	-2.1241	
2.44	3.57	0.009	-2.0377	*
4.88	8.33	0.011	-1.9514	**
4.88	13.10	0.014	-1.8650	**
0.00	13.10	0.017	-1.7786	
2.44	15.48	0.020	-1.6922	*
2.44	17.86	0.025	-1.6059	*
4.88	22.62	0.030	-1.5195	**
4.88	27.38	0.037	-1.4331	**
14.63	41.67	0.045	-1.3468	*****
4.88	46.43	0.055	-1.2604	**
12.20	58.33	0.067	-1.1740	*****
19.51	77.38	0.082	-1.0876	*****
12.20	89.29	0.100	-1.0013	*****
7.32	96.43	0.122	-0.9149	***
0.00	96.43	0.148	-0.8285	
0.00	96.43	0.181	-0.7422	
2.44	98.81	0.221	-0.6558	*

0                      1                      2                      3                      4

#####

20:54:51  
05/08/94

RFP / DU-3

LOGARITHMIC VALUES

=====

VARIABLE = U235

UNIT = PCI/

N = 41

N CI = 17

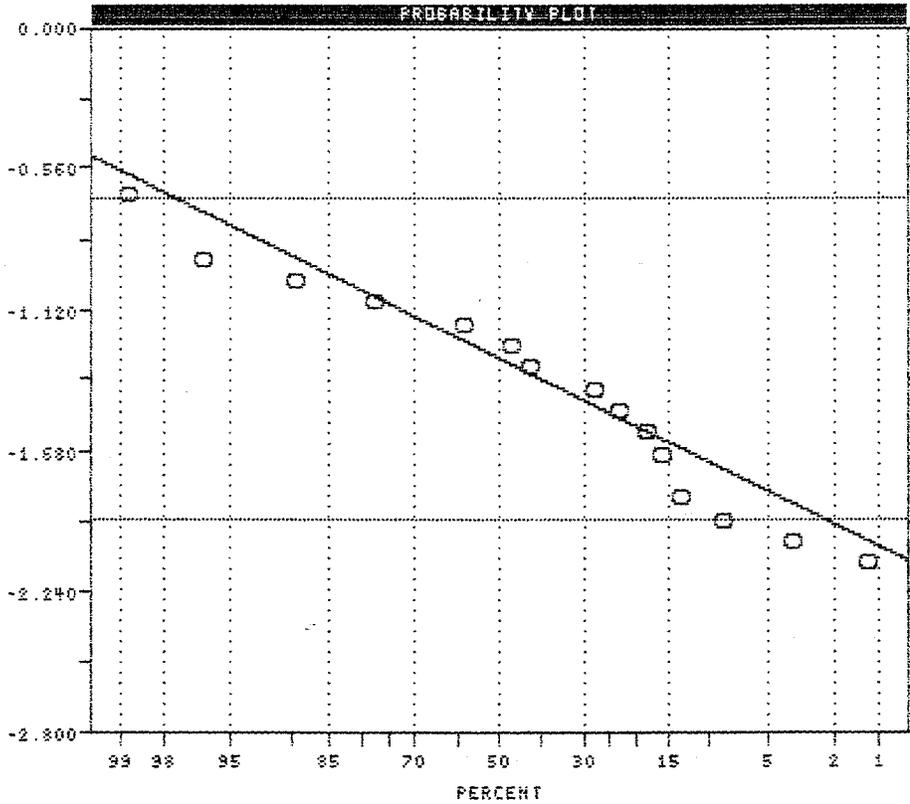
POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	-1.3185	0.3207	100.0

Pop.	THRESHOLDS	
1	-1.9599	-0.5771

RAW DATA ML  
PARAMETER ESTIMATES



20:55:54

SEP / JULY

05/08/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = U235-1D.DAT

Variable = U235 Unit = PCI/ N = 41  
N CI = 17

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 3.

1 Observations Were Below the Minimum Value of 0.0001

0 Observations Were Above the Maximum Value of 99999.9999

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -11.048

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.048	- 0.023 + 0.100	100.00

#####

15:53:05

RFP / DU-3: U235-S

07/08/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = U235 Unit = PCI/ N = 19

Mean = -1.2611 Min = -1.9161 1st Quartile = -1.5234  
 Std. Dev. = 0.3184 Max = -0.7696 Median = -1.1995  
 CV % = 25.2499 Skewness = -0.6126 3rd Quartile = -1.0147

Anti-Log Mean = 0.055 Anti-Log Std. Dev. : (-) 0.026  
 (+) 0.114

%	cum %	antilog	cls int	(# of bins = 13 - bin size = 0.0955)
0.00	2.50	0.011	-1.9639	
10.53	12.50	0.014	-1.8684	**
0.00	12.50	0.017	-1.7728	
0.00	12.50	0.021	-1.6773	
5.26	17.50	0.026	-1.5817	*
5.26	22.50	0.033	-1.4862	*
5.26	27.50	0.041	-1.3906	*
15.79	42.50	0.051	-1.2951	***
5.26	47.50	0.063	-1.1995	*
21.05	67.50	0.079	-1.1040	****
5.26	72.50	0.098	-1.0084	*
15.79	87.50	0.122	-0.9129	***
5.26	92.50	0.152	-0.8173	*
5.26	97.50	0.190	-0.7218	*

0                    1                    2                    3                    4

#####

15:53:57

07/08/94

RFP / DU-3: U235-S

LOGARITHMIC VALUES

=====

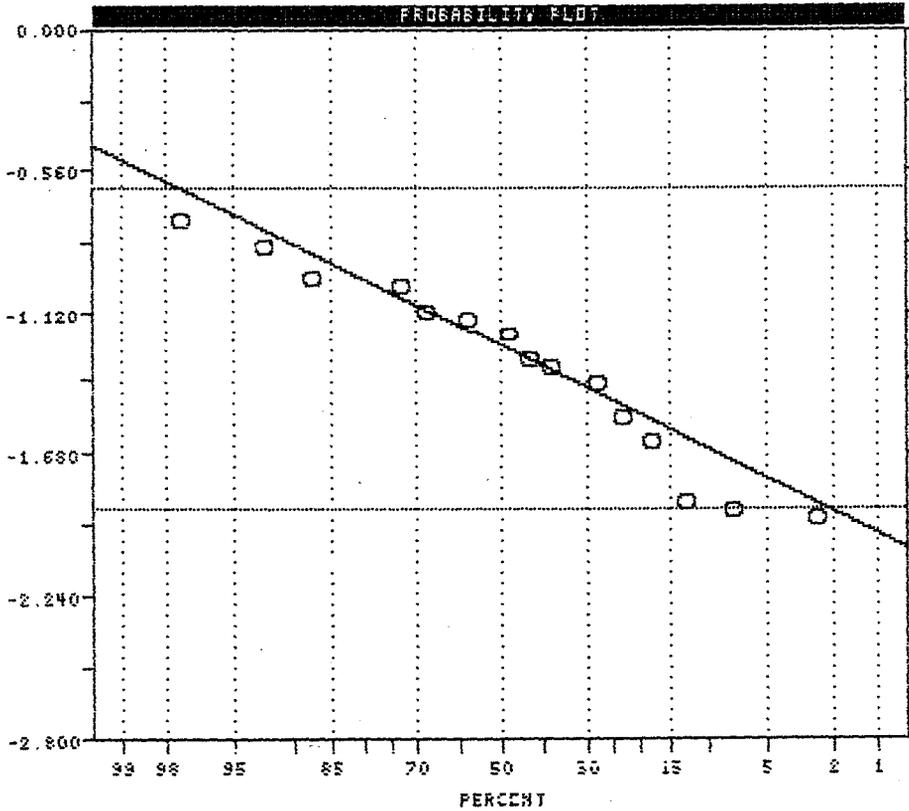
VARIABLE = U235  
 UNIT = PCI/  
 N = 19  
 N CI = 36

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	-1.2611	0.3184	100.0

Pop.	THRESHOLDS	
1	-1.8979	-0.6242



PARAM DATA HL  
 PARAMETER ESTIMATES

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = A:U235-S.DAT

Variable = U235 Unit = PCI/ N = 19  
N CI = 36

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -4.716

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	0.055	- 0.026 + 0.114	100.00

=====

Default Thresholds.

Standard Deviation Multiplier = 2.0

Pop.	Thresholds
1	0.013 0.238

#####

19:52:44

RFP / OU-3: As BS

05/17/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = **As** Unit = UG/ N = 33

Mean = 0.4039 Min = -0.1549 1st Quartile = 0.2094

Std. Dev. = 0.2790 Max = 0.8195 Median = 0.4022

CV % = 69.0652 Skewness = -0.2967 3rd Quartile = 0.6384

Anti-Log Mean = 2.535 Anti-Log Std. Dev. : (-) 1.333  
(+) 4.819

%	cum %	antilog	cls int	(# of bins = 16 - bin size = 0.0650)
0.00	1.47	0.650	-0.1874	
3.03	4.41	0.754	-0.1224	*
0.00	4.41	0.876	-0.0575	
12.12	16.18	1.017	0.0075	****
3.03	19.12	1.182	0.0725	*
3.03	22.06	1.372	0.1374	*
3.03	25.00	1.594	0.2024	*
6.06	30.88	1.851	0.2674	**
9.09	39.71	2.149	0.3323	***
6.06	45.59	2.496	0.3973	**
6.06	51.47	2.899	0.4622	**
12.12	63.24	3.367	0.5272	****
0.00	63.24	3.910	0.5922	
12.12	75.00	4.541	0.6571	****
9.09	83.82	5.274	0.7221	***
12.12	95.59	6.124	0.7871	****
3.03	98.53	7.113	0.8520	*

0 1 2 3 4

#####

19:54:24  
05/17/94

RFP / DU-3: As-BS

LOGARITHMIC VALUES

=====

VARIABLE = Ar  
UNIT = UG/  
N = 33  
N CI = 16

POPULATIONS

=====

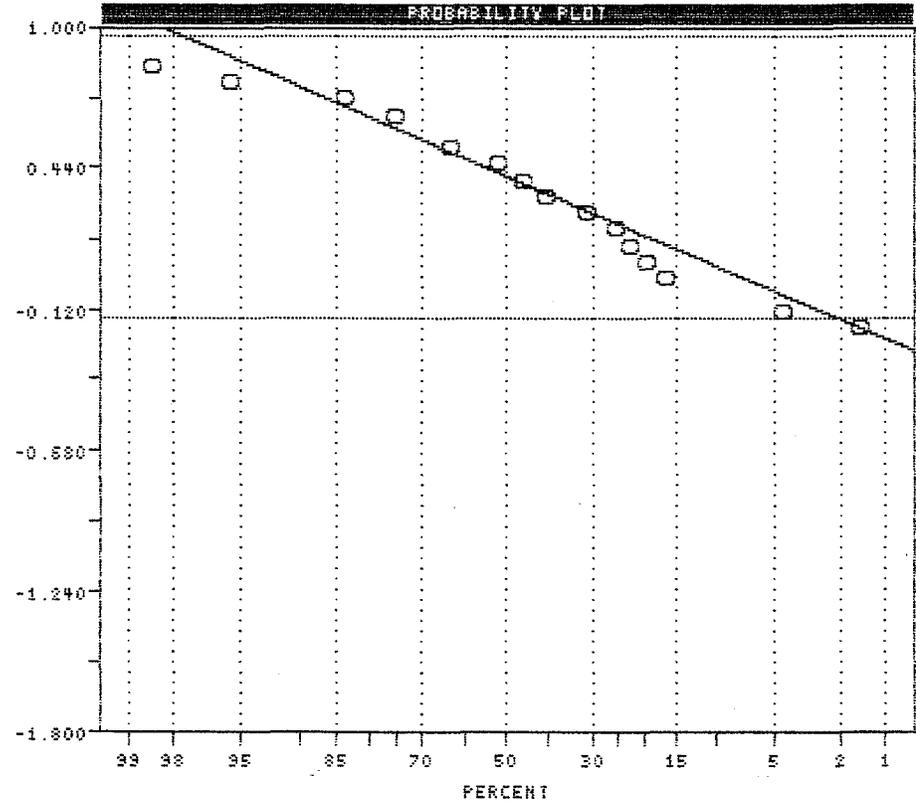
Pop.	Mean	Std.Dev.	%
1	0.4033	0.2730	100.0

Pop. THRESHOLDS

-----  
=====

1	-0.1540	0.9613
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RAW DATA ML  
PARAMETER ESTIMATES



19:55:28

RFP / OU-3: As-BS

05/17/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = AS-BS.DAT

Variable = Ar Unit = UG/ N = 33  
N CI = 16

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Raw Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -4.197

Parameterized Degrees of Freedom = 1

Population	Mean	Std Dev	Percentage
1	2.535	- 1.333 + 4.819	100.00

\*\*\*\*\*

19:44:47

RFP / DU-3: Fe-BS

05/17/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = Fe Unit = UG/ N = 218

Mean = 2.6381 Min = 0.9868 1st Quartile = 2.2455  
 Std. Dev. = 0.5671 Max = 4.4200 Median = 2.6762  
 CV % = 21.4968 Skewness = 0.0586 3rd Quartile = 2.9965

Anti-Log Mean = 434.653 Anti-Log Std. Dev. : (-) 117.768  
 (+) 1604.204

%	cum %	antilog	cls int	(# of bins = 24 - bin size = 0.1493)
0.00	0.23	8.168	0.9121	
0.46	0.68	11.519	1.0614	*
0.46	1.14	16.243	1.2107	*
0.00	1.14	22.906	1.3599	
0.00	1.14	32.301	1.5092	
3.67	4.79	45.549	1.6585	*****
4.59	9.36	64.232	1.8078	*****
2.29	11.64	90.577	1.9570	***
5.05	16.67	127.729	2.1063	*****
9.17	25.80	180.118	2.2556	*****
8.26	34.02	253.995	2.4048	*****
8.26	42.24	358.175	2.5541	*****
10.09	52.28	505.084	2.7034	*****
11.93	64.16	712.250	2.8526	*****
11.01	75.11	1004.388	3.0019	*****
10.55	85.62	1416.349	3.1512	*****
3.21	88.81	1997.281	3.3004	****
5.05	93.84	2816.489	3.4497	*****
0.92	94.75	3971.705	3.5990	*
2.75	97.49	5600.745	3.7482	***
0.46	97.95	7897.956	3.8975	*
0.46	98.40	11137.394	4.0468	*
0.46	98.86	15705.524	4.1961	*
0.46	99.32	22147.327	4.3453	*
0.46	99.77	31231.309	4.4946	*

0 1 2 3 4

Each "\*" represents approximately 1.7 observations.

#####

13:45:27  
05/17/94

RFP / DU-3: Fe-B3

LOGARITHMIC VALUES

-----

VARIABLE = Fe  
UNIT = UG/  
N = 218  
N CI = 24

POPULATIONS

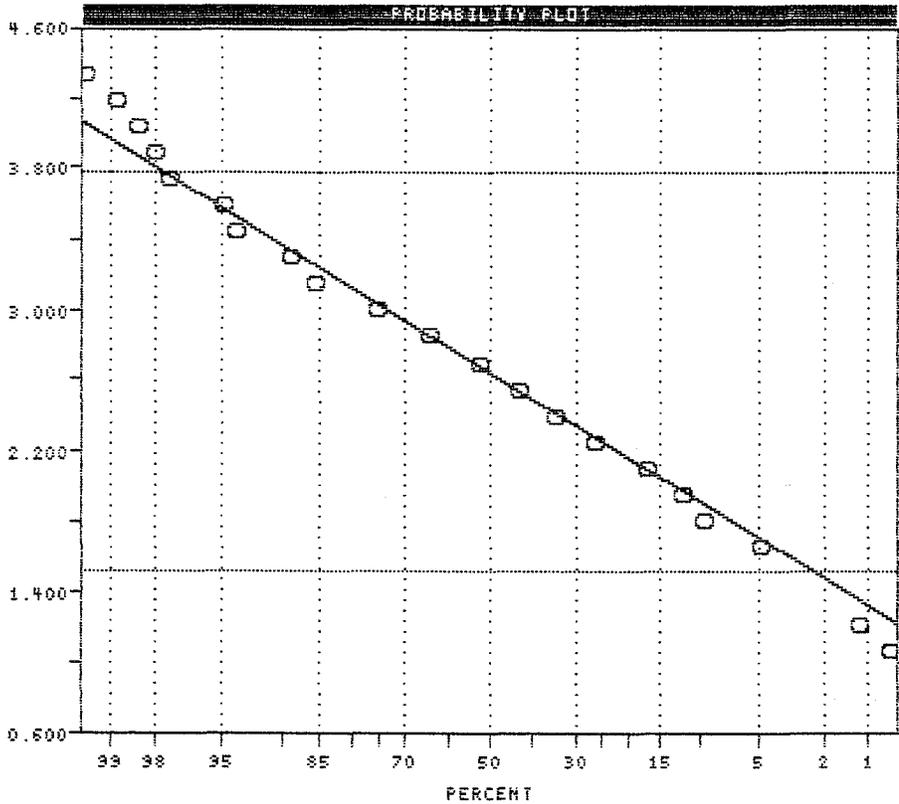
-----

Pop.	Mean	Std.Dev.	%
1	2.6381	0.5671	100.0

POP. THRESHOLDS

1	1.5039	3.7724
---	--------	--------

CLASS INTERVAL HL  
PARAMETER ESTIMATES



19:46:34

RFF / OU-3: Fe-BS

05/17/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = FE-BS.DAT

Variable = Fe Unit = UG/ N = 218  
N CI = 24

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

\*\*\*\*\*

Class Interval Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -592.772

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	434.653	- 117.768 + 1604.204	100.00

\*\*\*\*\*

21:54:50

RFP / OU-3: Pb-BS

05/17/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Pb	Unit =	UG/	N =	103
Mean =	0.5565	Min =	-0.0969	1st Quartile =	0.3641
Std. Dev. =	0.3067	Max =	1.5705	Median =	0.5250
CV % =	55.1123	Skewness =	0.5921	3rd Quartile =	0.7117
Anti-Log Mean =	3.602	Anti-Log Std. Dev. :	(-)	1.778	
			(+)	7.299	

%	cum %	antilog	cls int	(# of bins = 21 - bin size = 0.0834)
0.00	0.48	0.727	-0.1386	
0.97	1.44	0.881	-0.0552	*
1.94	3.37	1.067	0.0281	*
2.91	6.25	1.293	0.1115	**
1.94	8.17	1.566	0.1949	*
7.77	15.87	1.898	0.2783	*****
7.77	23.56	2.300	0.3616	*****
13.59	37.02	2.786	0.4450	*****
12.62	49.52	3.376	0.5284	*****
16.50	65.87	4.090	0.6118	*****
7.77	73.56	4.956	0.6951	*****
4.85	78.37	6.005	0.7785	****
2.91	81.25	7.276	0.8619	**
7.77	88.94	8.816	0.9452	*****
2.91	91.83	10.681	1.0286	**
2.91	94.71	12.942	1.1120	**
0.97	95.67	15.681	1.1954	*
1.94	97.60	18.999	1.2787	*
0.97	98.56	23.020	1.3621	*
0.00	98.56	27.892	1.4455	
0.00	98.56	33.795	1.5289	
0.97	99.52	40.948	1.6122	*

0 1 2 3 4

#####

21:55:44  
05/17/94

RFP / DU-3: PD-BS

LOGARITHMIC VALUES

=====

VARIABLE = Pb  
UNIT = UG/  
N = 103  
N CI = 21

POPULATIONS

=====

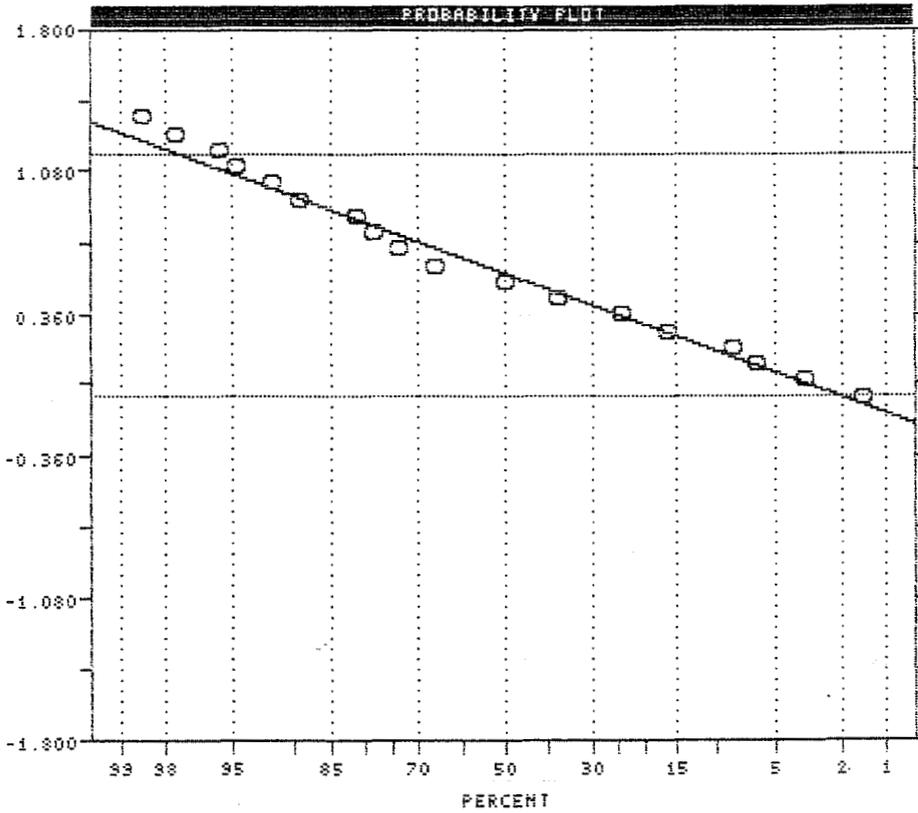
Pop.	Mean	Std.Dev.	%
1	0.5565	0.3067	100.0

Pop. THRESHOLDS

=====

1	-0.0569	1.1700
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CLASS INTERVAL ML  
PARAMETER ESTIMATES



21:56:45

RFP / OU-3: Pb-BS

05/17/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = PB-BS.DAT

Variable = Pb Unit = UG/ N = 103  
N CI = 21

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

\*\*\*\*\*

Class Interval Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -271.274

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	3.602	- 1.778 + 7.299	100.00

\*\*\*\*\*

19:40:44

RFP / DU-3: Mn-BS

05/17/94

#####  
SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable =	Mn	Unit =	UG/	N =	208
Mean =	1.5256	Min =	0.0000	1st Quartile =	1.1761
Std. Dev. =	0.5609	Max =	3.6085	Median =	1.5105
CV % =	36.7655	Skewness =	0.1778	3rd Quartile =	1.8854
Anti-Log Mean =	33.541	Anti-Log Std. Dev. :	(-) =	9.219	
			(+)	122.028	

%	cum %	antilog	cls int	(# of bins = 24 - bin size = 0.1569)
0.00	0.24	0.835	-0.0784	
0.48	0.72	1.198	0.0784	*
0.96	1.67	1.719	0.2353	*
1.44	3.11	2.467	0.3922	**
1.92	5.02	3.541	0.5491	**
2.88	7.89	5.082	0.7060	***
2.88	10.77	7.293	0.8629	***
4.81	15.55	10.466	1.0198	*****
10.10	25.60	15.021	1.1767	*****
11.06	36.60	21.557	1.3336	*****
10.58	47.13	30.937	1.4905	*****
15.38	62.44	44.399	1.6474	*****
8.65	71.05	63.718	1.8043	*****
6.73	77.75	91.444	1.9612	*****
8.65	86.36	131.234	2.1180	*****
5.29	91.63	188.339	2.2749	*****
3.37	94.98	270.292	2.4318	****
2.40	97.37	387.905	2.5887	***
0.96	98.33	556.695	2.7456	*
0.00	98.33	798.932	2.9025	
0.48	98.80	1146.575	3.0594	*
0.48	99.28	1645.489	3.2163	*
0.00	99.28	2361.497	3.3732	
0.00	99.28	3389.064	3.5301	
0.48	99.76	4863.761	3.6870	*

0 1 2 3 4

Each "\*" represents approximately 1.7 observations.

19:42:24  
05/17/94

RFP / DU-3: Mn-BS

LOGARITHMIC VALUES

=====

VARIABLE = Mn  
UNIT = UG/  
N = 208  
N CI = 24

POPULATIONS

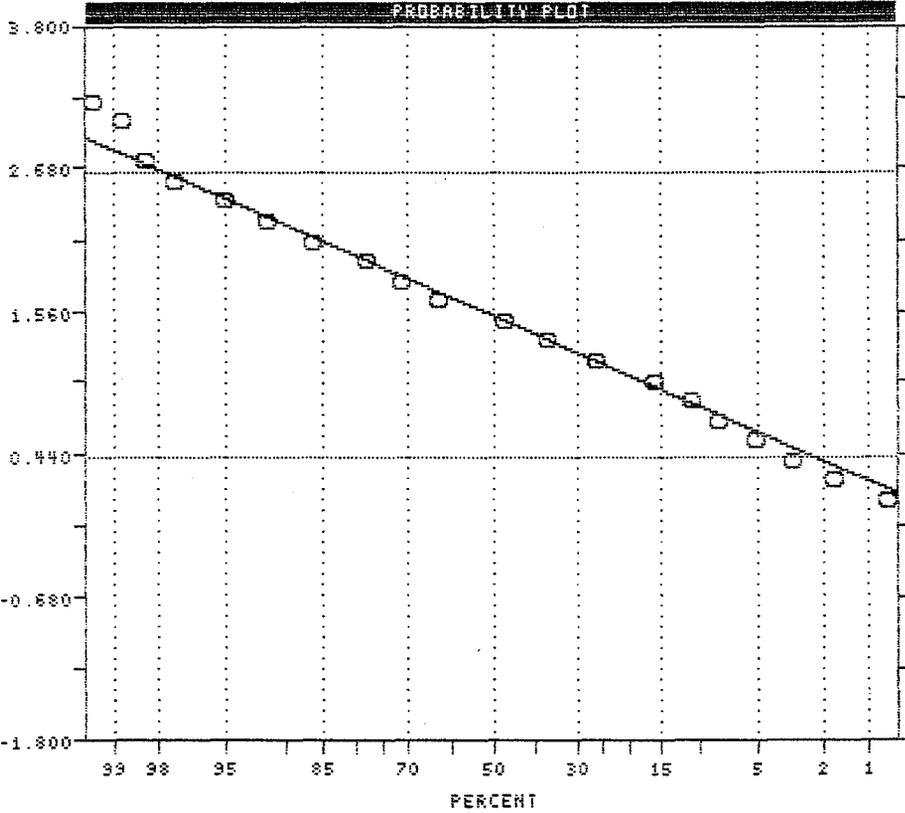
=====

Pop.	Mean	Std.Dev.	%
1	1.5256	0.5609	100.0

THRESHOLDS

Pop.	Lower	Upper
1	0.4038	2.6473

CLASS INTERVAL ML  
PARAMETER ESTIMATES



19:43:26

RFP / OU-3: Mn-BS

05/17/94

#####

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = MN-BS.DAT

Variable = Mn Unit = UG/ N = 208  
N CI = 24

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Class Interval Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -551.750

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	33.541	- 9.219 + 122.028	100.00

#####

21:49:53

RFP / OU-3: Si-BS

05/17/94

#####  
 SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES  
 #####

Variable = Si Unit = UG/ N = 118

Mean = 3.4591 Min = 2.5416 1st Quartile = 3.1418  
 Std. Dev. = 0.4050 Max = 4.1818 Median = 3.5119  
 CV % = 11.7070 Skewness = -0.2945 3rd Quartile = 3.7866

Anti-Log Mean = 2878.167 Anti-Log Std. Dev. : (-) 1132.806  
 (+) 7312.678

%	cum %	antilog	cls int	(# of bins = 21 - bin size = 0.0820)
0.00	0.42	316.645	2.5006	
1.69	2.10	382.460	2.5826	*
0.85	2.94	461.954	2.6646	*
2.54	5.46	557.972	2.7466	**
2.54	7.98	673.947	2.8286	**
3.39	11.34	814.027	2.9106	***
5.08	16.39	983.223	2.9927	****
3.39	19.75	1187.586	3.0747	***
6.78	26.47	1434.427	3.1567	*****
5.93	32.35	1732.573	3.2387	*****
3.39	35.71	2092.690	3.3207	***
5.93	41.60	2527.656	3.4027	*****
7.63	49.16	3053.031	3.4847	*****
5.93	55.04	3687.606	3.5667	*****
9.32	64.29	4454.077	3.6488	*****
4.24	68.49	5379.859	3.7308	****
7.63	76.05	6498.066	3.8128	*****
9.32	85.29	7848.693	3.8948	*****
5.93	91.18	9480.048	3.9768	*****
4.24	95.38	11450.482	4.0588	****
3.39	98.74	13830.471	4.1408	***
0.85	99.58	16705.143	4.2229	*

0                    1                    2                    3                    4

#####

21:50:44  
05/17/94

RFP / QU-3: SI-B5

LOGARITHMIC VALUES

=====

VARIABLE = SI  
UNIT = UG/  
N = 118  
N CI = 21

POPULATIONS

=====

Pop.	Mean	Std.Dev.	%
1	3.4531	0.4050	100.0

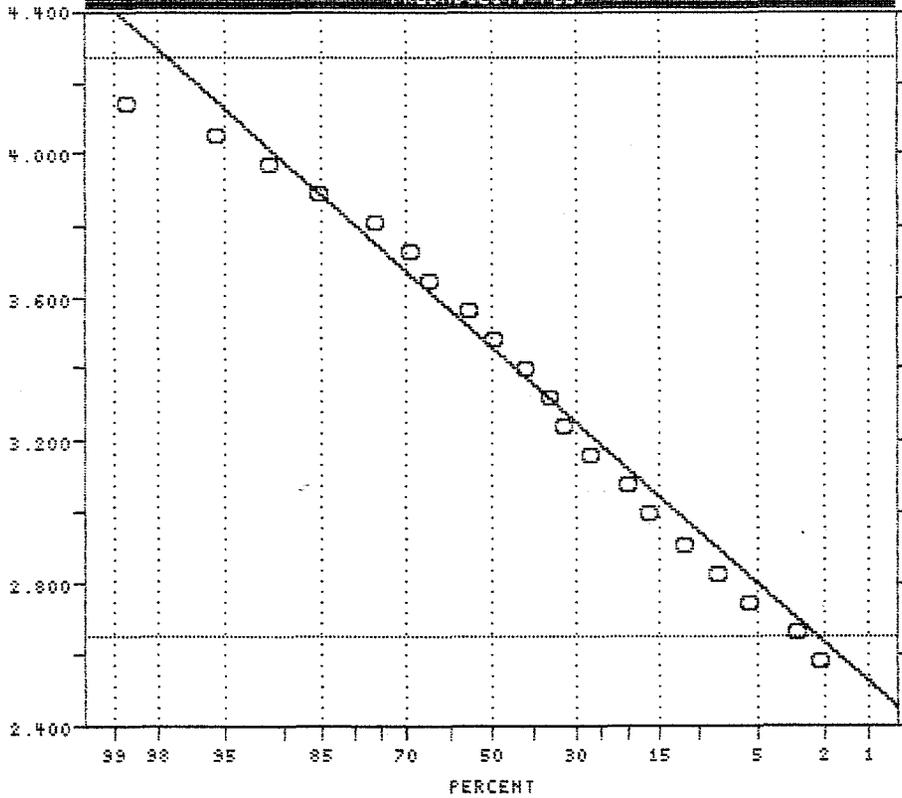
POP. THRESHOLDS

=====

1	2.6492	4.2690
---	--------	--------

CLASS INTERVAL ML  
PARAMETER ESTIMATES

PROBABILITY PLOT



21:51:47

RFP / OU-3: SI-BS

05/17/94

\*\*\*\*\*

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = SI-BS.DAT

Variable = Si Unit = UG/ N = 118  
N CI = 21

Transform = Logarithmic Number of Populations = 1

# of Missing Observations = 0.

=====

Class Interval Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -351.202

Parameterized Degrees of Freedom = 1

<u>Population</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Percentage</u>
1	2878.167	- 1132.806 + 7312.678	100.00

\*\*\*\*\*

Non-Controlled Document  
Draft

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## APPENDIX H. CDPHE/EPA/DOE GUIDANCE FOR THE COC SELECTION PROCESS

Appendix H contains copies of the following CDPHE/EPA/DOE guidance for the COC selection process and the Data Aggregation process:

- Attachment 1 – Memorandum from Jessie Roberson (DOE, Memo Reference No. ER:SRG:03600), dated March 30, 1994, describing Data Aggregation methodologies, including the CDPHE Conservative Screen.
- Attachment 2 – Memorandum from Martin Hestmark (EPA) confirming the *background comparison methodologies to be used for OU 3 (i.e., weight-of-evidence evaluations for reservoirs)* as part of the Data Aggregation process.

DOCF 1528.8

United States Government

Department of Energy

**memorandum**

Rocky Flats Office

DATE: MAR 30 1994

REPLY TO  
ATTN OF: ER-SRG:03600

COPY

SUBJECT: Resumption of All Work on Operable Unit Baseline Risk Assessments

TO: Sue Stiger, Associate General Manager  
Environmental Restoration Management  
EG&G Rocky Flats, Inc.

Memorandum ER-SRG:03599 provides instruction for you to resume all work associated with Environmental Restoration Operable Unit (OU) baseline risk assessments that were stopped by memorandum ERD:SRG:08450, dated August 18, 1993.

We reference the following memorandums concerning resumption of work for contaminants of concern and statistical comparisons with background for the baseline risk assessments:

- ERD:SRG:11731; October 13, 1993: resumption of Contaminant of Concern selection and statistical comparisons of data to background for OU2.
- ERD:EAD:13759; December 22, 1993: resumption of statistical comparisons of data to background for all operable units.
- EG&G memorandum 94-RF-02971 - SG-179-94; March 14, 1994: methodology for statistical comparisons of data to background.

We have just recently reached agreement with the Environmental Protection Agency (EPA) and the Colorado Department of Health on the methodology for data aggregation and the methodology is attached.

You are directed to revise the schedules for the Operable Units to incorporate the agreed-upon risk assessment methodology by April 25, 1994. In particular, the data aggregation methodology represents "additional work or modifications to work" as per Part 32 of the Interagency Agreement (IAG). As a result, we must determine revised schedules and cost, including the additional scope to incorporate the revised methodology, and make a request to EPA and CDH as per Part 42 (Extensions) of the IAG.

Your April 25, 1994 deliverable to us will include schedule extensions for all Operable Units affected by the stoppage of work, and will specifically denote the time needed (with sufficient rationale) for the "additional work." This is an important distinction because the IAG allows a day-for-day schedule extension (Paragraph 164 of the IAG) for the time the work stoppage was in affect and a schedule extension should easily be granted. However, the time needed for additional work is not as straightforward, and as a result, needs a substantial rationale to support the request for additional time needed.

APR- 4-94 MON 12:37  
MAR-31-94 THU 10:21

ENV RESTORATION DIVISION FMA NO. 4011

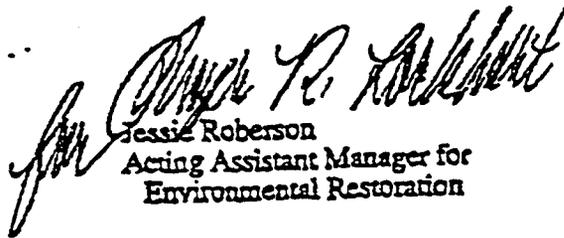
P. 04  
11.00

S. Stiger  
ER-SRG-03600

2

MAR 30 1994  
---

If you have any questions please contact Frazer Lockhart at extension 7846.

  
Jessie Roberson  
Acting Assistant Manager for  
Environmental Restoration

cc w/attachment:  
A. Rampertaap, EM-453  
F. Lockhart, ER, RFO  
B. Thatcher, ER, RFO  
S. Grace, ER, RFO  
J. Pepe, ER, RFO  
R. Birk, ER, RFO  
H. Rose, ER, RFO  
W. Busby, EG&G  
R. Roberts, EG&G

## DATA AGGREGATION FOR HEALTH EXPOSURE ASSESSMENT

### Specific Data Aggregation Methodology for Rocky Flats

The first consideration of data aggregation is the exposure scenario (land use). Example exposure areas for the Rocky Flats Plant site may be (1) for the industrial/commercial land use scenario, the area of a typical industrial park (2) for the ecological preserve scenario, the area of a preserve, and (3) for the residential land use scenario, the area of a residential neighborhood unless the consideration of a receptor's activity patterns and the mechanisms of toxicity of a particular contaminant indicate that a residential lot size is appropriate.

Following the application of the attached conservative screen (which identifies areas of elevated contaminant concentration which will be the focus of the baseline risk assessment), data must be aggregated for each environmental medium to arrive at the exposure point concentration estimate which will be used in the exposure assessment. Aggregation of all contaminant data, including data below background or detection limits, will be accomplished over the scenario-specific exposure areas within the area of concern identified by the screening process. The recommended data aggregation procedure is as follows:

- 1) Identify the exposure scenario(s) which will be assessed.
- 2) Agree on the size of the exposure area for each scenario by considering the receptors, the toxicity of the contaminants of concern (COCs), the exposure pathways, and contaminant variability. Determination of the appropriate exposure area requires an understanding of the mechanisms of toxicity as well as the concepts of exposure. For this reason, experienced risk assessors, toxicologists, and health physicists from all three agencies (EPA, CDH, and DOE) must be consulted.
- 3) Plot the COC data, including data points below background or detection limit, on a map of the operable unit, delineating the area of concern\*.
- 4) Consult with toxicologists and health physicists from all three agencies (EPA, CDH, and DOE) to place a grid of exposure areas over the area of concern. The grid placement must be approved by the three agency toxicologists and health physicists due to considerations of mechanisms of toxicity. Of course, involvement of other scientific disciplines will also be required.

- \* Area of Concern = One or several sources\*\* grouped spatially in close proximity.
- \*\* Source = Area defined by (1) contaminant levels exceeding background mean plus 2 standard deviations for inorganics and/or (2) detection limits for organics.

- 5) Risk assessment requires characterization of each exposure area for the site (OSWER Directive 9285.7-09A, April, 1992, p. 55). Generally this requires aggregation of data and a subsequent calculation of risk within each exposure area. This is especially important for heterogeneous data sets. However, at the Rocky Flats site, all parties agree that it is sufficient to calculate risks for only one exposure area per source: the exposure area associated with the highest risk, identified by considering the concentrations of COCs, the affected environmental media, and the number of exposure pathways. If the exposure area associated with the highest risk is not readily identifiable, several exposure areas may be analyzed. This decision will be made on a case-by-case basis. In general, not more than one exposure area per source will need to be evaluated unless the exposure pathways differ between exposure areas within the source. Data within the exposure area(s) will be aggregated using the following procedure:
- a. Using the complete operable unit data set, determine the statistical distribution for each COC in each environmental media. Present the statistical distribution graphically, along with the data plotted in a histogram which presents the frequency of detection and the magnitude.
  - b. Use EPA's "Supplemental Guidance to RAGS: Calculating the Concentration Term" to calculate the 95th percent upper confidence limit (95% UCL) of the arithmetic mean over each exposure area for each COC. If the COC data is log-normally distributed, highlight 5 of this guidance document should be used. If the COC data is normally distributed or is determined to be non-parametric, highlight 6 should be used. The guidance states that calculation of the 95% UCL using data sets with fewer than 10 samples per exposure area provides a poor estimate of the mean concentration. Data sets with 20 to 30 samples per exposure area provide fairly consistent estimate of the mean. All parties agree that uncertainties in the estimates of the mean concentrations will be addressed in the uncertainty analysis. For OUs 2-7, additional field sampling in support of baseline risk assessment must be mutually agreed to by EPA, CDH, and DOE. On a case-by-case basis, with the approval of the regulators, geostatistics may be utilized to incorporate spatial continuity of data.
- 6) Use the results of step 5(b) as the exposure point concentration term in the exposure assessment. Consider all COCs in calculating cumulative risks for each exposure area analyzed.

### Summary

The above procedure provides the arithmetic average of the exposure concentration that is expected to be contacted over the exposure period within the exposure area associated with the maximum risk within the source. Although this concentration does not reflect the maximum concentration that could be contacted at any one time, it is explicitly stated in OSWER Publication 9285.7-081, "Supplemental Guidance to RAGS: Calculating the Concentration Term", the average is used for two reasons:

1. carcinogenic and chronic noncarcinogenic toxicity criteria are based on lifetime average exposures; and
2. average concentration is most representative of the concentration that would be contacted over time if it is assumed that an exposed individual moves randomly across an exposure area.

Considerations of risk due to exposure to a source of contamination will be addressed because all COC data will be considered with respect to how a potential receptor may be exposed, not simply how the contamination is distributed in the environment.



Conservative Risk Screen for Sources<sup>1)</sup> at the Rocky Flats Plant

This risk screen will be the first step in the risk assessment process used at Rocky Flats and will be the basis and justification for the type of next steps taken at a given OU (please see attached flow-chart).

The steps in the conservative risk screen are as follows:

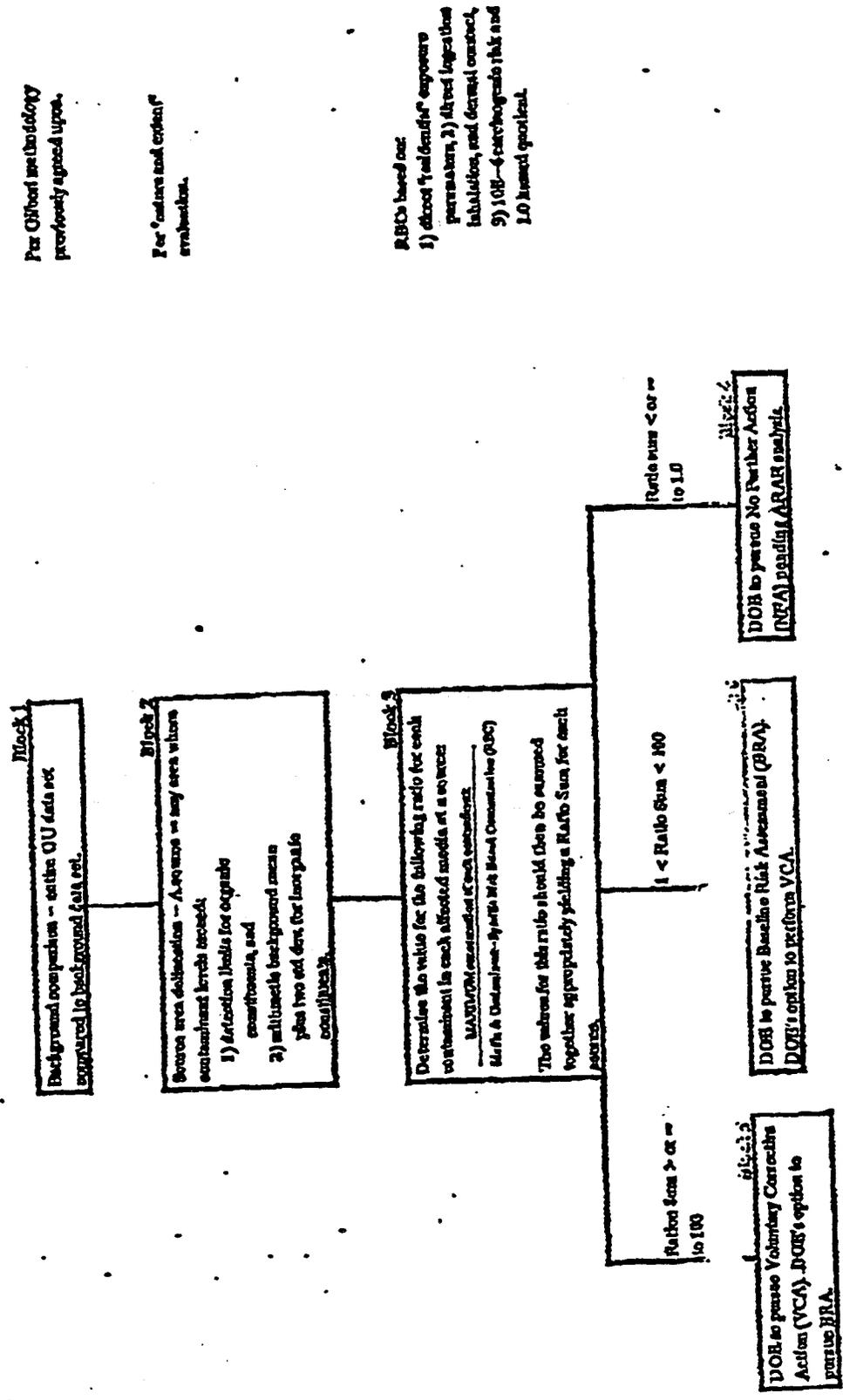
1. An entire OU RFI/RI data base will be compared to background using the previously agreed upon Gilbert methodology. (flowchart, block 1)
  - The product of the background comparison will be a list of potential contaminants in the OU. This list will consist of all organic chemicals that exceed detection limit somewhere in the OU, and all inorganic chemicals whose OU population exhibits a significant statistical increase in concentrations compared to the background population either over the whole OU or within some portion of the OU.
2. This list of potential contaminants will be used as the basis for the "nature and extent" evaluation for each OU. Within this evaluation, source areas will be delineated. For organic chemicals on the list, the delineation criteria will be the detection limit; for inorganic chemicals on the list, the delineation criteria will be the arithmetic mean of the background data set plus two standard deviations from the arithmetic mean. (flowchart, block 2)
  - It is recognized that each chemical in each medium may have a different spatial extent within a source. These different spatial extents do not affect the implementation of this screen. A "source," however, will be all contamination that can reasonably be tied together based on existing knowledge of the site, contaminant types, concentrations, rates of migration, etc.
3. For each potential contaminant in each medium, a medium-specific "risk based concentration", or RBC, must be calculated. These RBCs should be calculated based on: 1) direct "residential" exposure and intake parameters, 2) direct ingestion, dermal contact, and inhalation pathways only, and 3) assuming a carcinogenic risk of  $1 \times 10^{-4}$  and a non-carcinogenic hazard quotient of 1.0. (These RBCs could be calculated once site-wide since they are chemical-specific and not location specific.)

---

<sup>1)</sup> Source - Area defined by 1) contaminant levels exceeding background mean plus 2 standard deviations for inorganics and/or 2) detection limits for organics

4. For each source delineated in #2 above, it is necessary to determine the maximum contaminant levels for each potential contaminant in each affected medium.
5. Once the maximum contaminant levels have been determined, each media/contaminant-specific maximum should be divided by its respective RBC. These maximum/RBC ratios for each contaminant should then be summed for each medium and then across all affected media in a source. Those sources where the ratio sum is less than 1.0 have a risk less than  $1 \times 10^{-4}$  and/or a hazard quotient less than 1.0. Those sources where the ratio sum is greater than 1.0 have a risk greater than  $1 \times 10^{-4}$  and/or a hazard quotient greater than 1.0. (flowchart, block 3)
6. For sources where the ratio sum was less than 1.0, DOE would pursue a "no further action" decision, pending an ARAE analysis (flowchart, block 4). For sources that have a ratio sum greater than 100, DOE would pursue a "voluntary corrective action" but could proceed with a Baseline Risk Assessment (BRA) at their discretion (flowchart, block 5). For sources where the ratio sum was between 1.0 and 100, DOE would pursue a BRA, but could perform a voluntary corrective action at their discretion (flowchart, block 6).

# CONSERVATIVE RISK SCREEN



Per ODFW methodology  
proficiency agreed upon.

Per ODFW and certain  
evaluators.

RBCs based on:  
1) direct "real time" exposure  
parameters, 2) direct ingestion  
habitation, and direct contact,  
3) 108-4 carcinogens risk and  
1.0 based on total.



## UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII

999 18th STREET - SUITE 500  
DENVER, COLORADO 80202-2466

MAR 24 1994

Ref: 8HWM-FF

Mr. Richard Schassburger  
U.S. Department of Energy  
Rocky Flats Office  
P.O. Box 928  
Golden, CO 80402-0928RE: Operable Unit 3  
Comparisons to Background Data

Dear Mr. Schassburger:

Representatives of EPA, CDH, and DOE contractors met on March 10, 1994, to discuss options for comparing the remedial investigation data collected from Mower Reservoir, Standley Lake Reservoir, and Great Western Reservoir to background data. The intent of this letter is to document the agreement reached at this meeting.

EPA and CDH agree that a weight of evidence approach may be used to address the question of whether metals and radionuclides in the reservoirs are above background levels. The evidence considered should include, but may not be limited to the following:

1. A comparison of stream sediment data in the Operable Unit 3 (OU 3) drainages to background concentrations of stream sediments in the Background Geochemical Report. Those constituents above background in the drainages should be considered as potentially above background in the reservoirs.
2. A comparison of reservoir data to appropriate background values taken from the existing scientific literature.
3. A consideration of the results of remedial investigation sediment sampling in the Woman Creek and the Walnut Creek drainages (Operable Unit 5 and Operable Unit 6) to determine potential releases into the off site reservoirs.

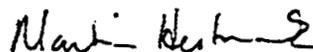
We understand that this approach deviates from the standard protocol for making background comparisons at the Rocky Flats site which was recommended by Dr. Richard Gilbert of Battelle Pacific Northwest Laboratories and accepted by all three Interagency Agreement parties in a facilitated process (EPA letter dated October 25, 1993; CDH letter dated

October 13, 1993). The protocol is highly statistically based. A key assumption is that the background data set is representative.

The available data characterizing background concentrations of reservoir sediments is sparse, therefore, a deviation from Dr. Gilbert's approach is warranted in the case of OU 3 reservoir sediments. In fact, we believe that if DOE were to use Dr. Gilbert's approach, the conclusions would be less supportable than a weight of evidence approach.

If there are any questions regarding this issue, please direct them to Bonnie Lavelle of EPA at (303) 294-1067, or Dave Norberry of CDH at (303) 692-3415.

Sincerely,



Martin Hestmark, Manager  
Rocky Flats Project

cc: Bob Birk, DOE  
Mark Buddy, EG&G  
Joe Schieffelin, CDH  
Dave Norberry, CDH

# **NOTICE:**

**“BEST AVAILABLE COPY”**

**PORTIONS OF THE FOLLOWING  
DOCUMENT ARE ILLEGIBLE**

Figure 2-1

# Surface Soil Sample Locations

**OPERABLE UNIT 3**  
**IHSS 199 Surface Soils Sampling Area**  
**ROCKY FLATS**  
**ENVIRONMENTAL TECHNOLOGY SITE**  
**U.S. Department of Energy**

Surface Soil Plot

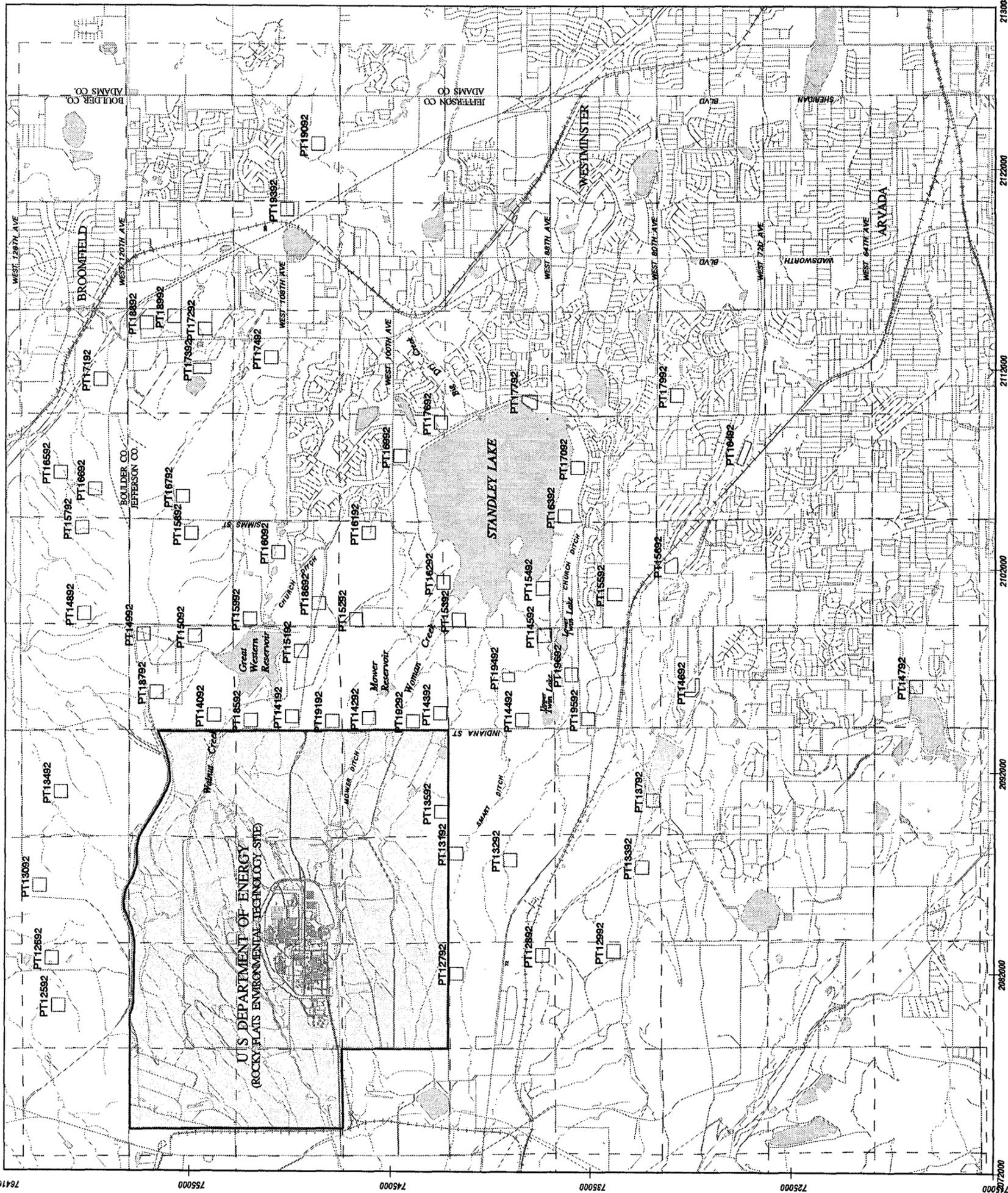


Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

Scale 1:63360  
1 inch = 1 mile



Polyconic projection, 1927 North American datum.  
Colorado central zone state plane coordinate system.



**Figure 2-2  
RFI / RI  
Sediment Grab  
and Core  
Sample Locations**

OPERABLE UNIT 3  
IHSS 200 Great Western Reservoir  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy

- 1992 Sediment core sample
- 1992 Sediment grab sample
- 1983/84 Sediment sample

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey



Scale 1 : 6000  
1 inch = 500 ft



SCALE IN FEET

Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.



( ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE )

U. S. DEPARTMENT OF ENERGY

**Figure 2-3  
RFI / RI  
Sediment Grab  
Sample Locations**

**OPERABLE UNIT 3  
IHSS 201 Standley Lake  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy**

- 1992 Sediment grab sample
- 1983/84 Sediment sample

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

Scale 1 : 15840  
1 inch = 1320 ft or 0.25 mi

Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.

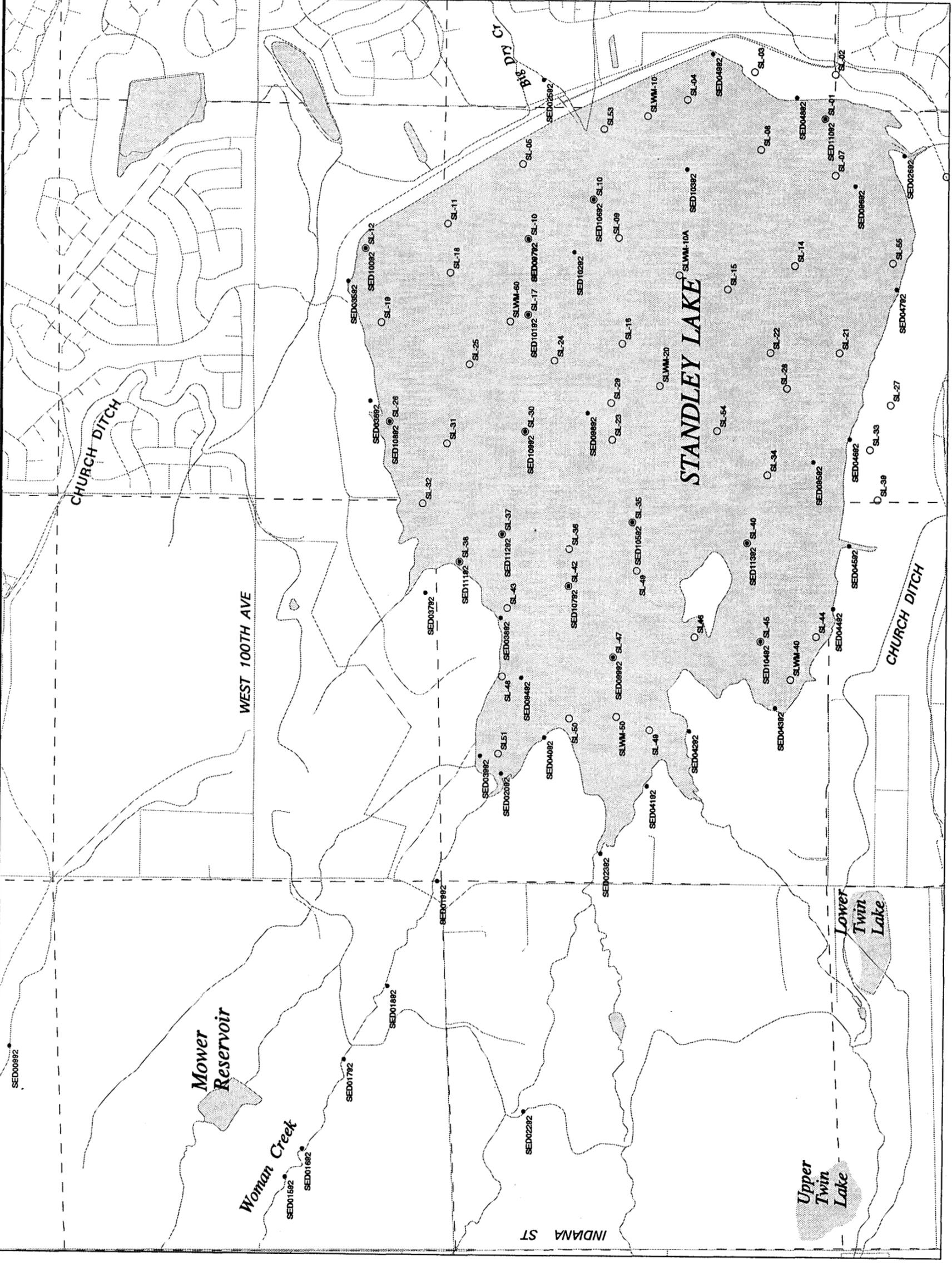


Figure 2-4  
RFI / RI  
Sediment Grab  
Sample Locations

OPERABLE UNIT 3  
IHSS 202 Mower Reservoir  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy

- 1992 Sediment grab sample

Note: No sediment samples were collected in Mower Reservoir as part of the 1983/84 sampling event.

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

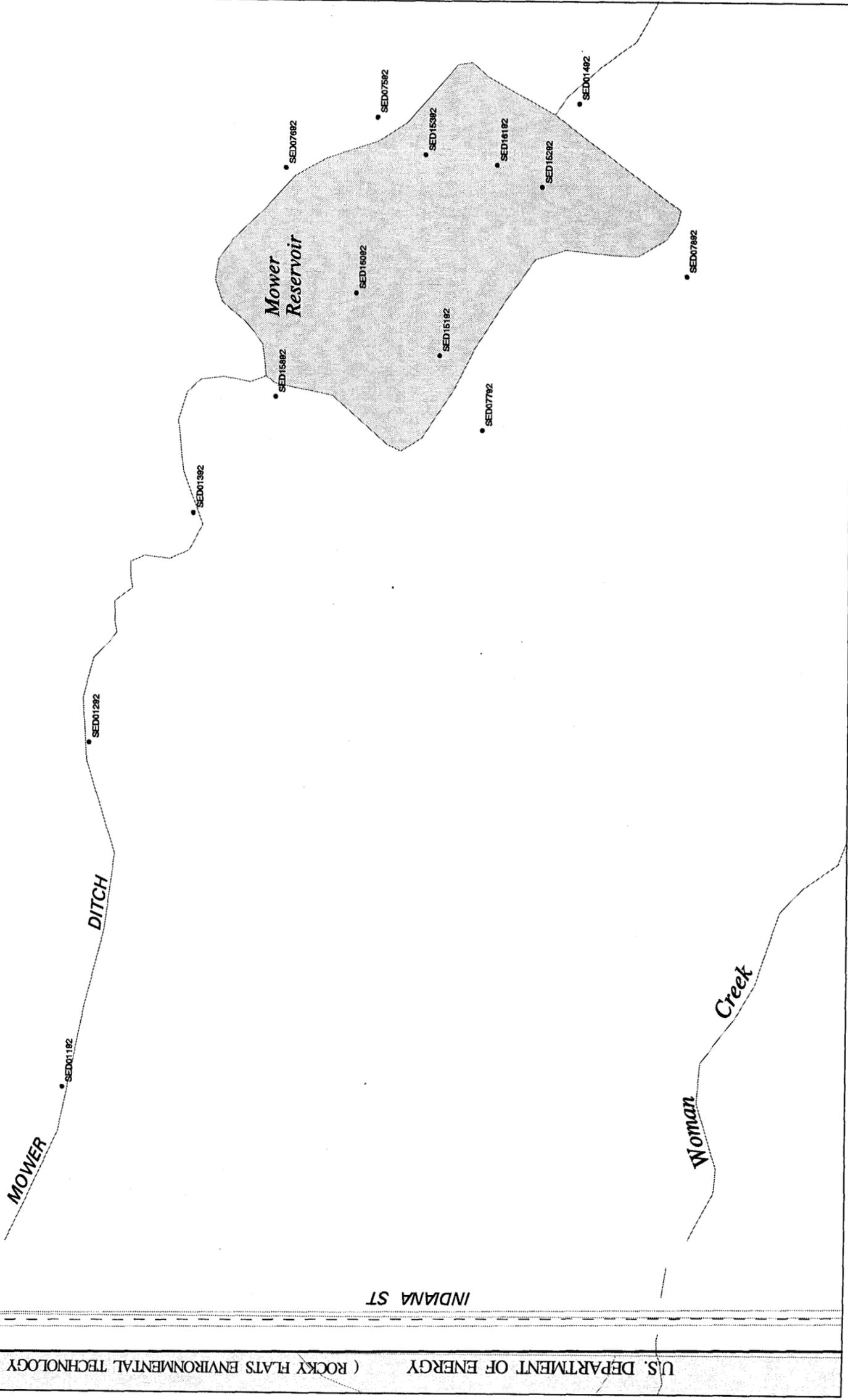


Scale 1 : 2400  
1 inch = 200 ft



SCALE IN FEET

Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.



U.S. DEPARTMENT OF ENERGY ( ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE)

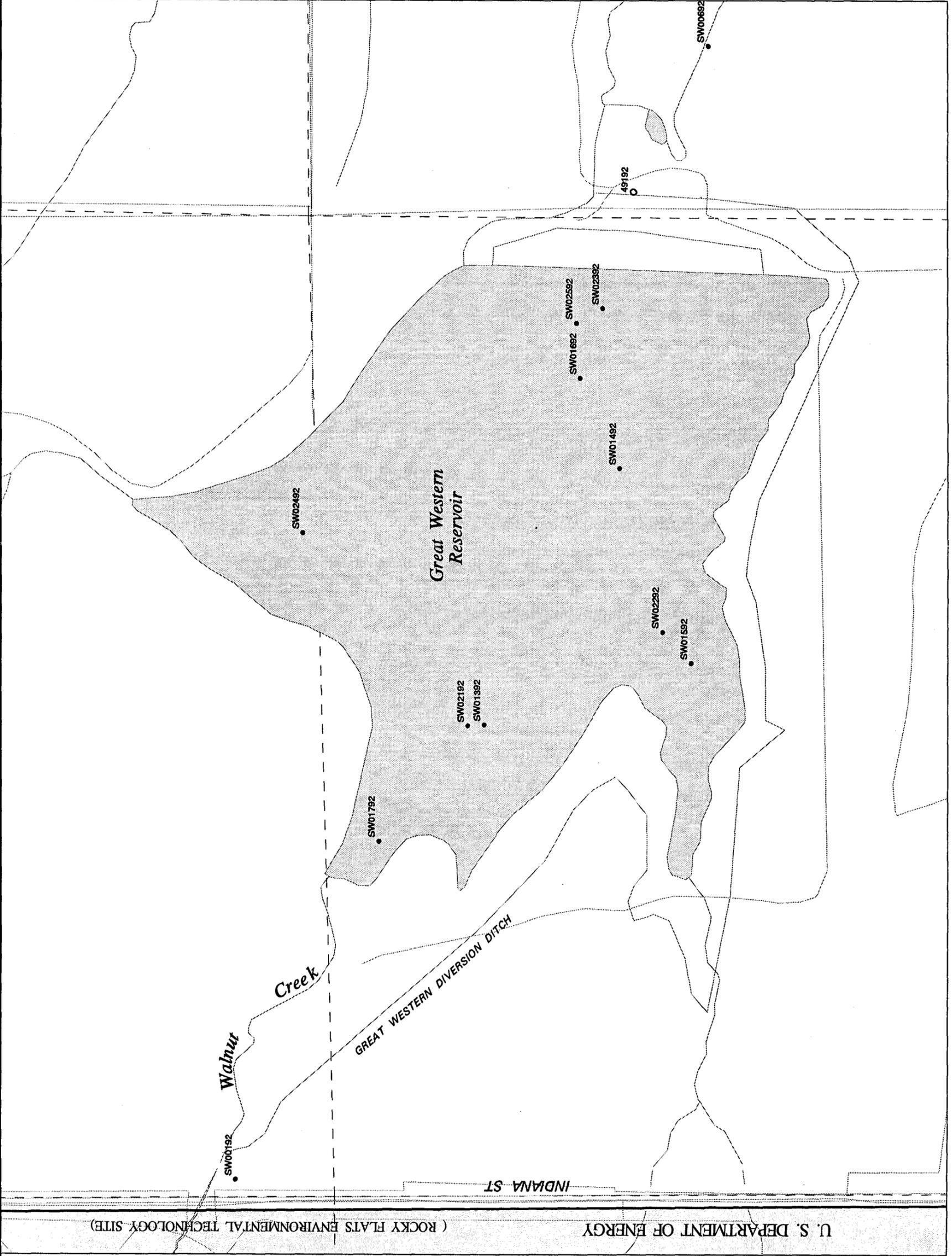
Figure 2-5  
RFI / RI  
Surface Water  
and Ground Water  
Sample Locations

OPERABLE UNIT 3  
IHSS 200 Great Western Reservoir  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

Scale 1 : 6000  
1 inch = 500 ft  
0 250 500 1000  
SCALE IN FEET

Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.



U. S. DEPARTMENT OF ENERGY  
( ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE )

Figure 2-6  
RFI / RI  
Surface Water  
and Ground Water  
Sample Locations

OPERABLE UNIT 3  
IHSS 201 Standley Lake  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy

- Surface water sample
- Ground water sample

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

Scale 1 : 15840  
1 inch = 1320 ft or 0.25 mi



North arrow pointing up.

Polyconic projection. 1927 North American datum. Colorado central zone state plane coordinate system.

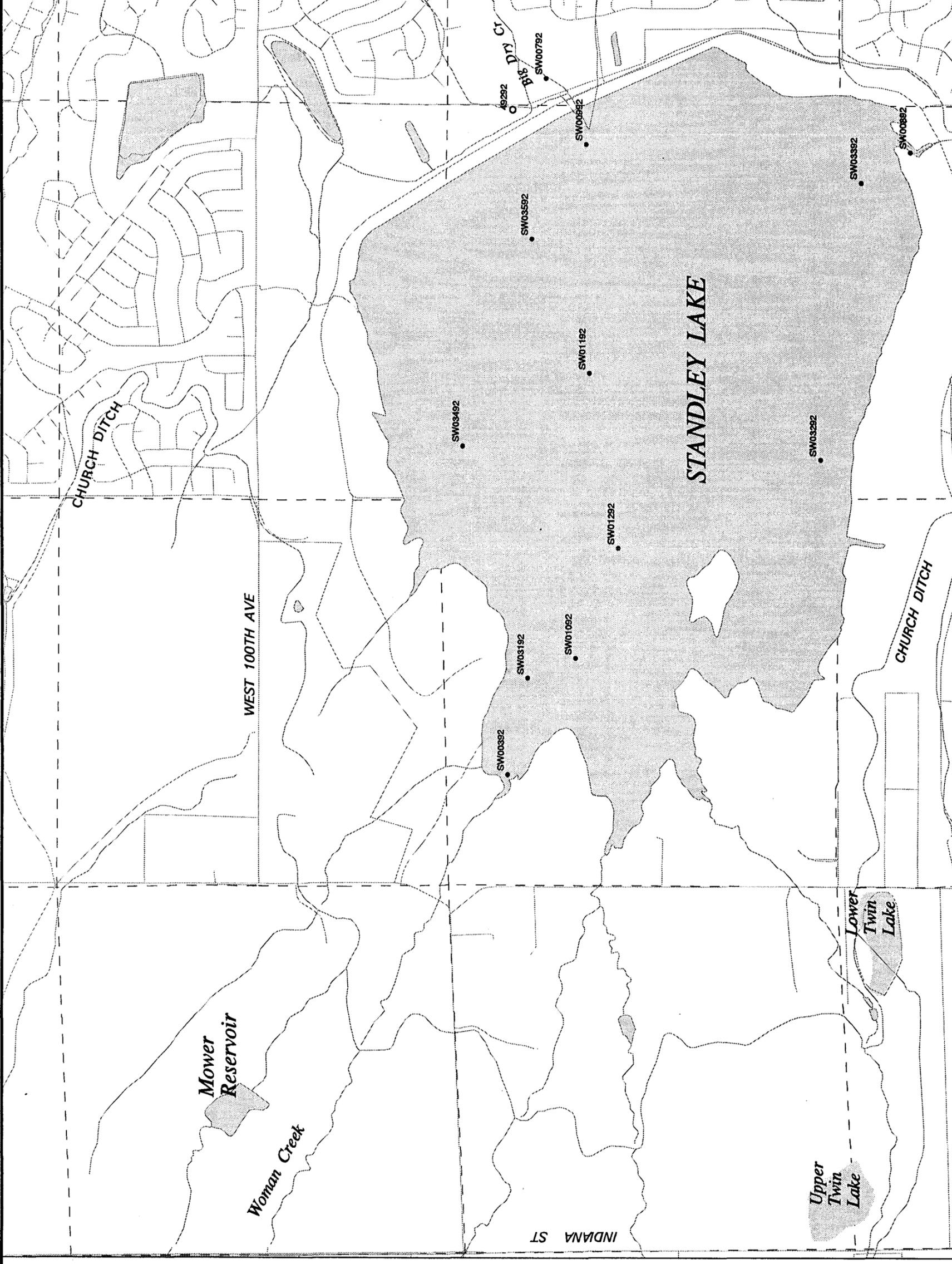


Figure 2-7  
RFI / RI  
Surface Water  
Sample Locations

OPERABLE UNIT 3  
IHSS 202 Mower Reservoir  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

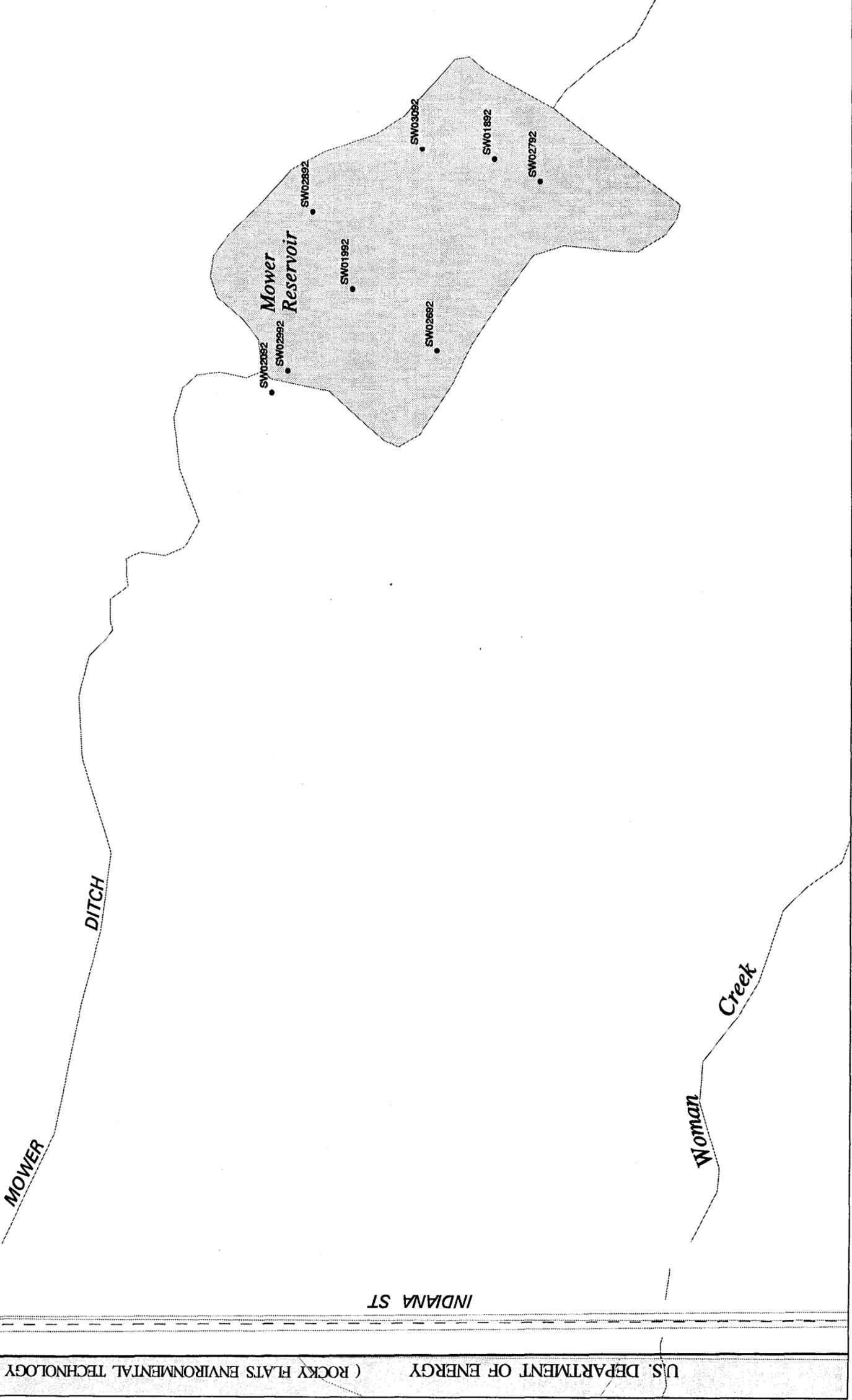


Scale 1 : 2400  
1 inch = 200 ft



SCALE IN FEET

Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.



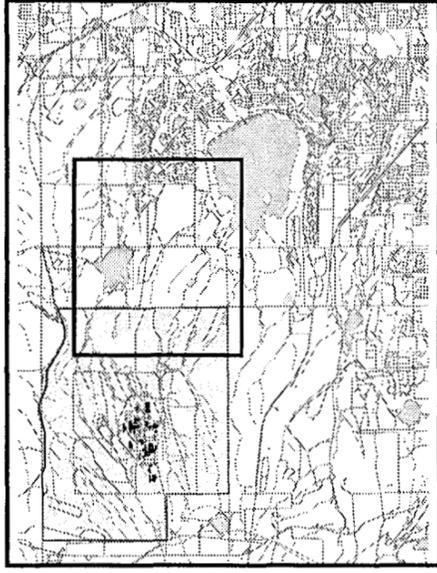
• Surface water sample

U.S. DEPARTMENT OF ENERGY (ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE)

Figure 2-8

# Jefferson County Remedy Acres Surface Soil Samples

OPERABLE UNIT 3  
IHSS 199 Surface Soils Sampling Area  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy



Key Map

untilled  
filled  
Jefferson County Remedy Acres

Mapping Sources:  
Jefferson County Mapping Dept  
EG&G Rocky Flats  
U.S. Geological Survey

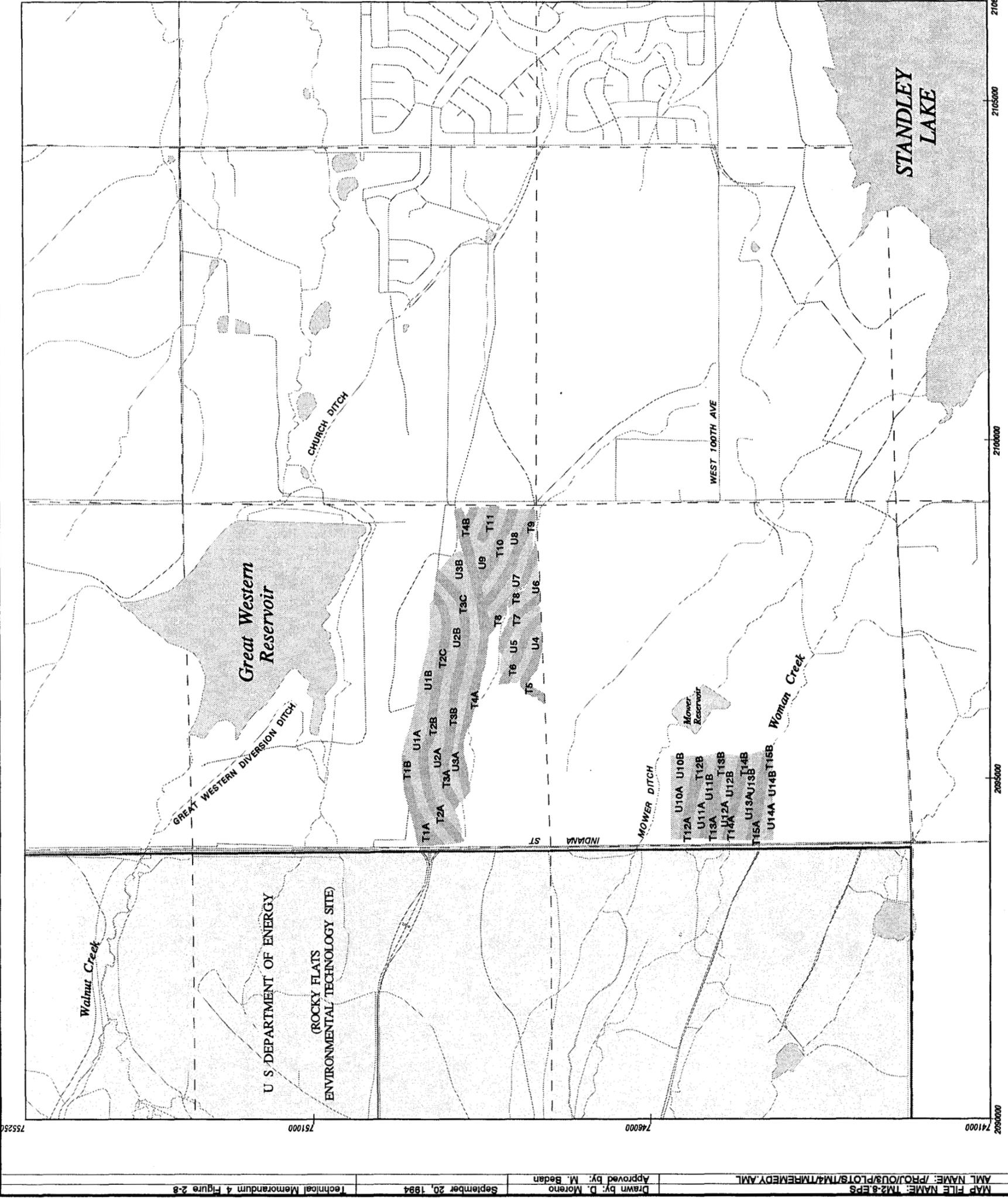


Scale 1 : 18000  
1 inch = 1500 ft

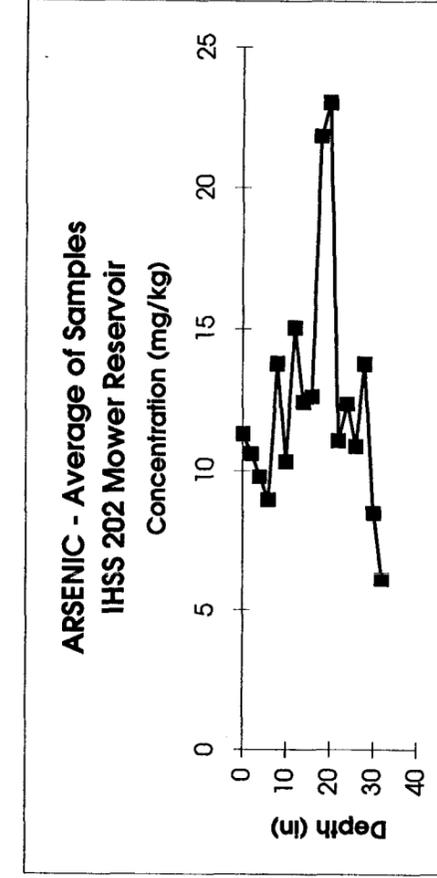
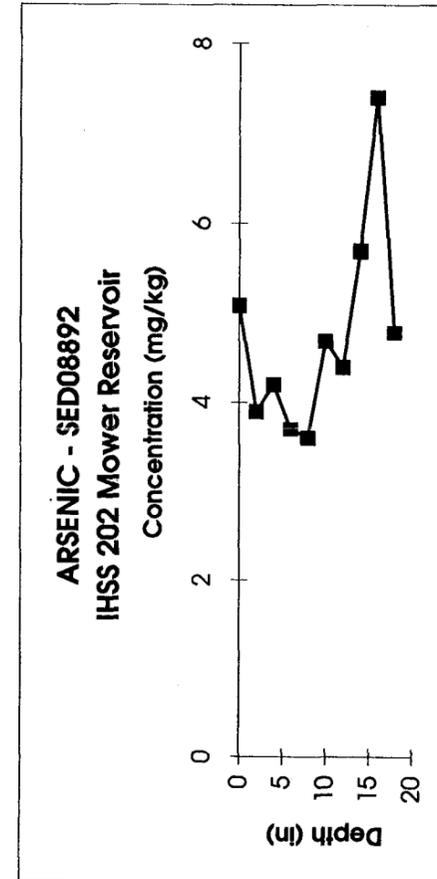
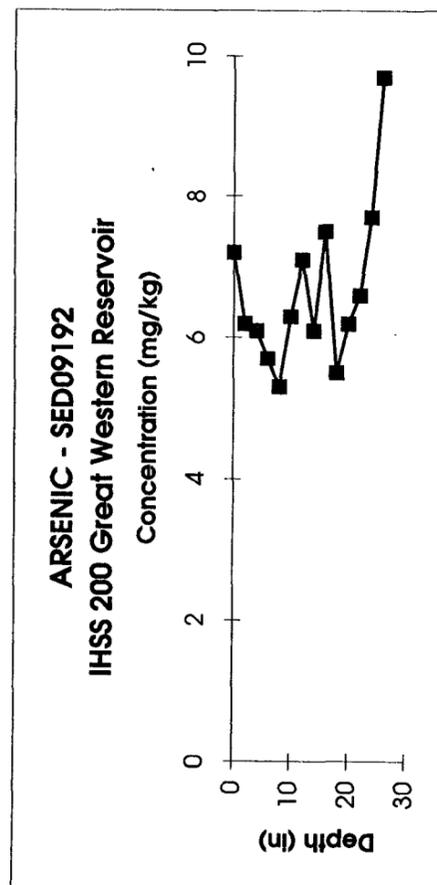
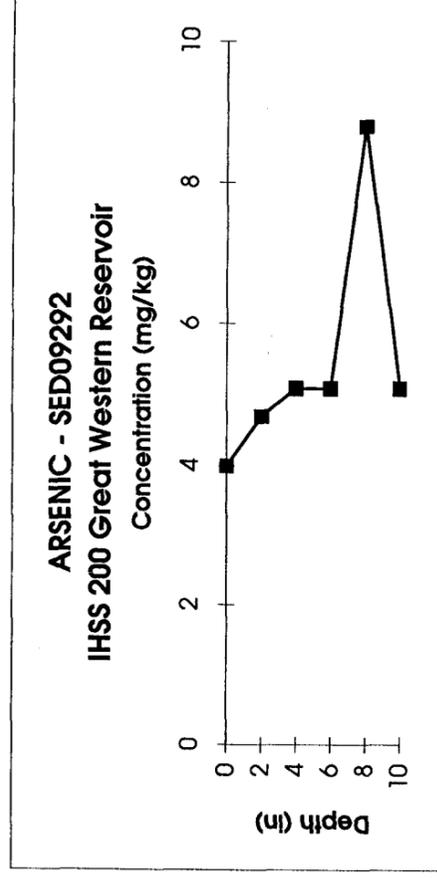
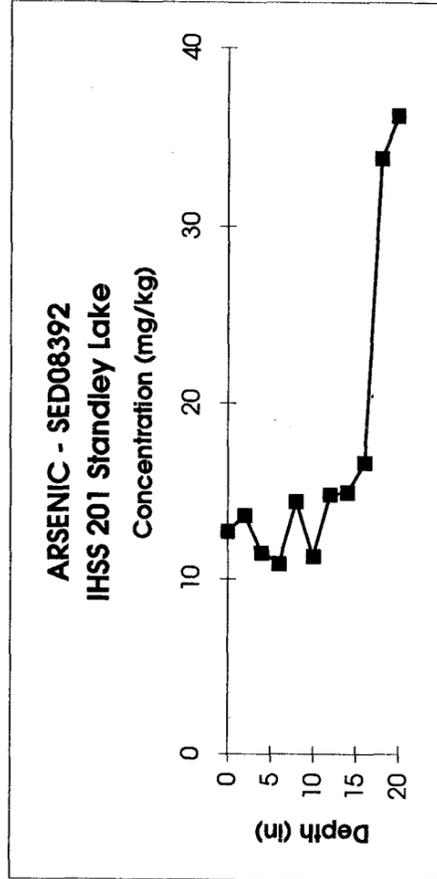
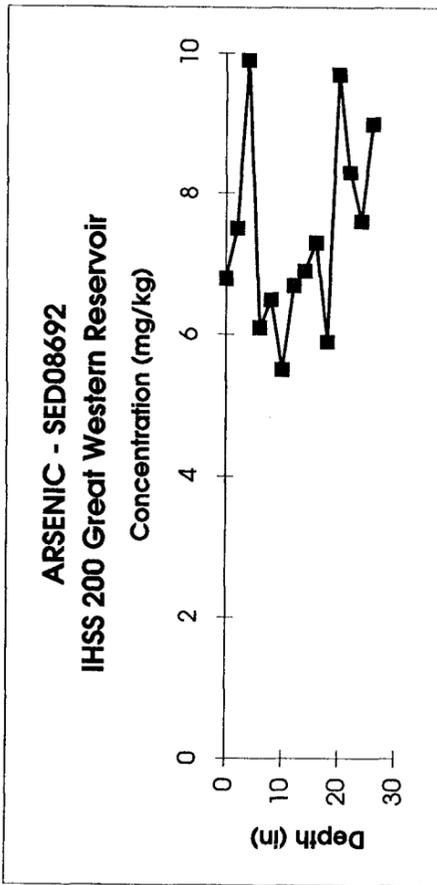
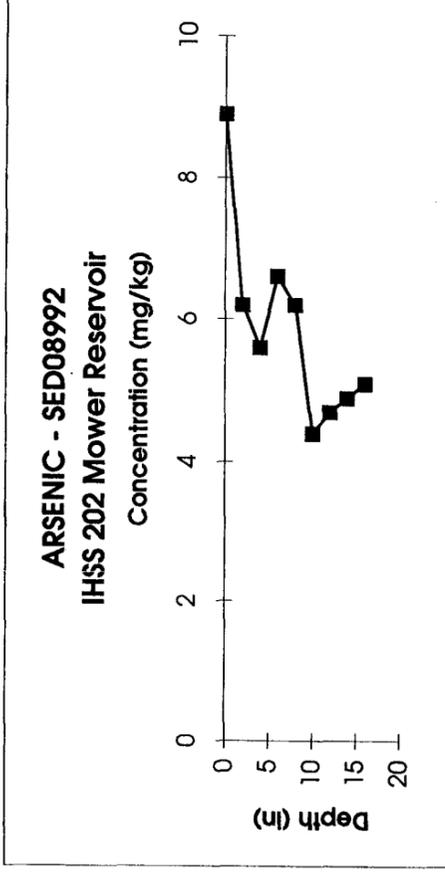
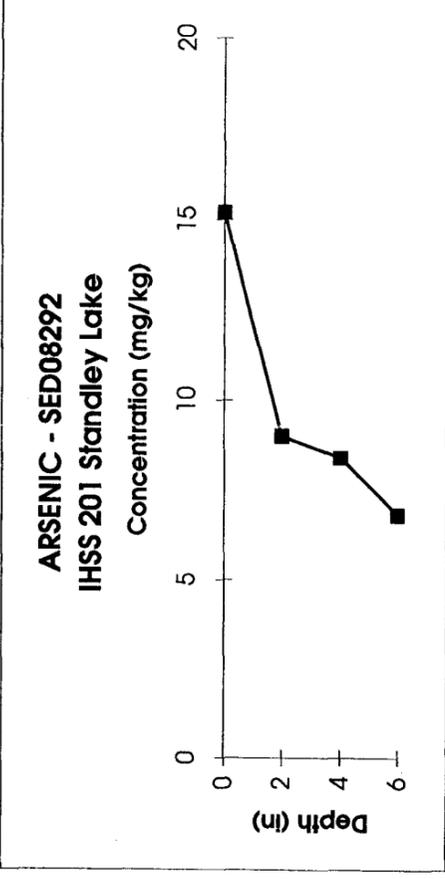
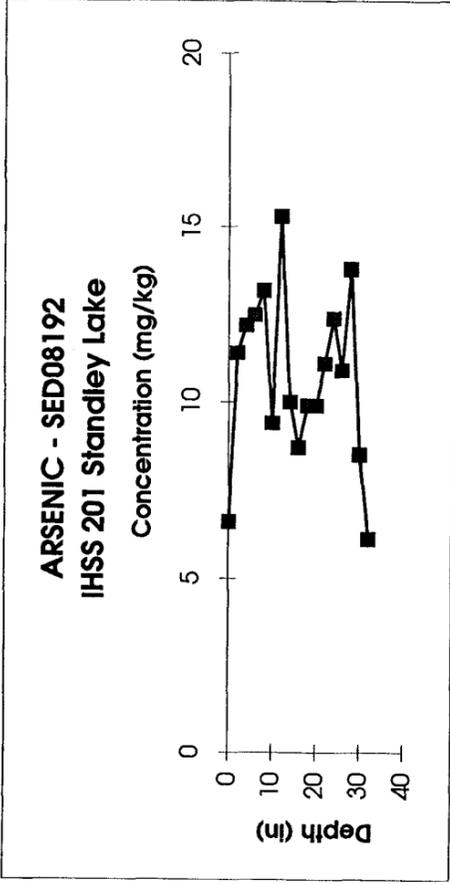


SCALE IN FEET

Polyconic projection, 1927 North American datum.  
Colorado central zone state plane coordinate system.







Non-Controlled Document

TABLE 7-2  
 SUMMARY STATISTICS BY WELL FOR OU 3 FOR PARAMETERS EXCEEDING PRGS

Well #	Test Group	Chemical	Unit of Measure	OU 3 Groundwater Data										Background Geochemical Characterization Report Data (DOE, 1993c)					Benchmark Data				
				No. of Detects	No. of Samples	Frequency of Detection	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	Arithmetic Mean	Standard Deviation	Coefficient of Variation	Upper Hydrostratigraphic Unit (UHSU)					Lower Hydrostratigraphic Unit (LHSU)				
														Minimum	Maximum	Arithmetic Mean	Standard Deviation	Mean Plus 2 Standard Deviations	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Mean Plus 2 Standard Deviations
<b>IHSS 200</b>																							
49192	TMETAL	ALUMINUM	µg/L	8	8	1	965	23400	8499.375	9254.58	1.09	22.6	19950	2742.8	4248.73	11240.26	11	11700	1792	2773.43	7338.86	<5	1000
49192	TMETAL	ANTIMONY	µg/L	1	8	0.125	27.5	27.5	12.75	7.23	0.57	3.6	86.6	19.19	12.85	44.89	3.5	41.3	15.62	10.4	36.42	<5	1000
49192	TMETAL	ARSENIC	µg/L	5	8	0.625	2.3	6.9	2.99375	2.13	0.71	0.35	5	1.95	1.71	5.37	0.35	7	2.76	2.02	6.8	<1	30
49192	TMETAL	BERYLLIUM	µg/L	4	8	0.5	1.1	1.6	0.9125	0.47	0.52	0.4	4.8	1.07	0.87	2.81	0.3	2.5	0.86	0.74	2.34	<10	10
49192	TMETAL	CESIUM	µg/L	2	8	0.25	12	50	19.9375	14.22	0.71	2	500	154.42	198.79	552	2	500	131.59	175.16	481.91	<10	10
49192	TMETAL	COBALT	µg/L	4	8	0.5	5.3	16.6	6.4	5.66	0.89	1	39.4	7.64	9.67	26.98	1	25	5.55	8.18	21.91	<10	10
49192	TMETAL	LEAD	µg/L	7	8	0.875	1.8	20.1	7.8875	7.72	0.98	0.5	25	3.26	3.64	10.54	0.5	17.7	3.82	4.29	12.4	<15	15
49192	TMETAL	LITHIUM	µg/L	8	8	1	349	465	420.5	39.00	0.09	1.1	266	33.75	48.76	131.27	6.2	106	40.69	29.29	99.27	<1	150
49192	TMETAL	MANGANESE	µg/L	8	8	1	327	959	485.25	227.26	0.47	0.5	584	79.59	108.18	295.95	1	710	61.87	125.21	312.29	<1	1000
49192	TRADS	SILICON	µg/L	8	8	1	8140	53600	23485	18505.90	0.79	4399	51650	15564.97	10797.33	37159.63	3720	29500	9427.5	6631.12	22689.74	5000	100000
49192	TRADS	URANIUM 233/234	pCi/L	2	2	1	3.4	4.6	4	0.85	0.21	0	164	15.62	38.75	93.12	0.15	1.32	0.77	0.57	1.91	<1	100000
49192	TRADS	URANIUM 238	pCi/L	2	2	1	2.1	4.2	3.15	1.48	0.47	0	108	10.84	27.73	66.3	0.17	0.53	0.35	0.26	0.87	<5	100000
<b>IHSS 201</b>																							
49292	TMETAL	ALUMINUM	µg/L	5	8	0.625	24.1	46.8	72.01875	108.71	1.51	22.6	19950	2742.8	4248.73	11240.26	11	11700	1792	2773.43	7338.86	<5	1000
49292	TMETAL	ARSENIC	µg/L	5	8	0.625	2.7	3.8	2.525	1.07	0.42	0.35	5	1.95	1.71	5.37	0.35	7	2.76	2.02	6.8	<1	30
49292	TMETAL	LEAD	µg/L	1	8	0.125	1.7	1.7	0.775	0.44	0.56	0.5	25	3.26	3.64	10.54	0.5	17.7	3.82	4.29	12.4	<15	15
49292	TMETAL	LITHIUM	µg/L	8	8	1	72.2	78.6	74.85	2.06	0.03	1.1	266	33.75	48.76	131.27	6.2	106	40.69	29.29	99.27	<1	150
49292	TMETAL	SILICON	µg/L	8	8	1	5110	6260	5535	432.63	0.08	4399	51650	15564.97	10797.33	37159.63	3720	29500	9427.5	6631.12	22689.74	5000	100000

TMETAL = Total metals  
 TRADS = Total radionuclides

**Figure F-1**  
**Analytical Results of Selected Metals for Sediment Samples**

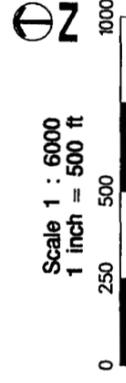
OPERABLE UNIT 3  
 IHSS 200 Great Western Reservoir  
 ROCKY FLATS  
 ENVIRONMENTAL TECHNOLOGY SITE  
 U.S. Department of Energy

Analyte Symbols:  
 As Arsenic  
 Be Beryllium  
 Ca Calcium  
 Cr Chromium  
 Fe Iron  
 Mn Manganese  
 Zn Zinc

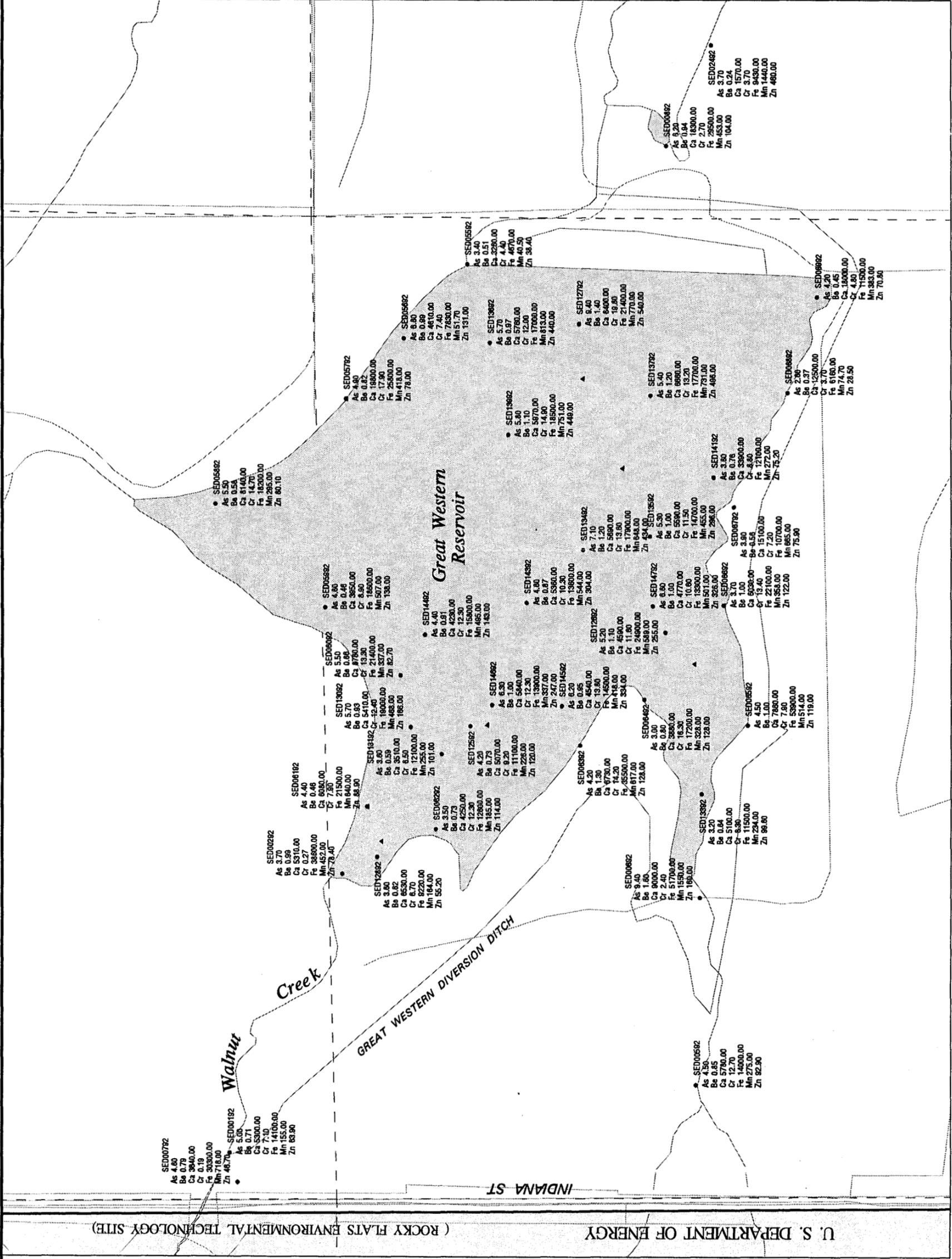
Units are mg/kg.

- 1992 Sediment core sample
- 1992 Sediment grab sample

Mapping Sources:  
 Jefferson County Mapping Dept.  
 EG&G Rocky Flats  
 U.S. Geological Survey



Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.



U. S. DEPARTMENT OF ENERGY  
 ( ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE )

Figure F-2

# Analytical Results of Selected Metals for Sediment Samples

OPERABLE UNIT 3  
IHSS 201 Standley Lake  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy

Analyte Symbols:  
As Arsenic  
Be Beryllium  
Ca Calcium  
Cr Chromium  
Fe Iron  
Mn Manganese  
Zn Zinc

Units are mg/kg.

• 1992 Sediment grab sample

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

Scale 1 : 15840  
1 inch = 1320 ft or 0.25 mi



Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.

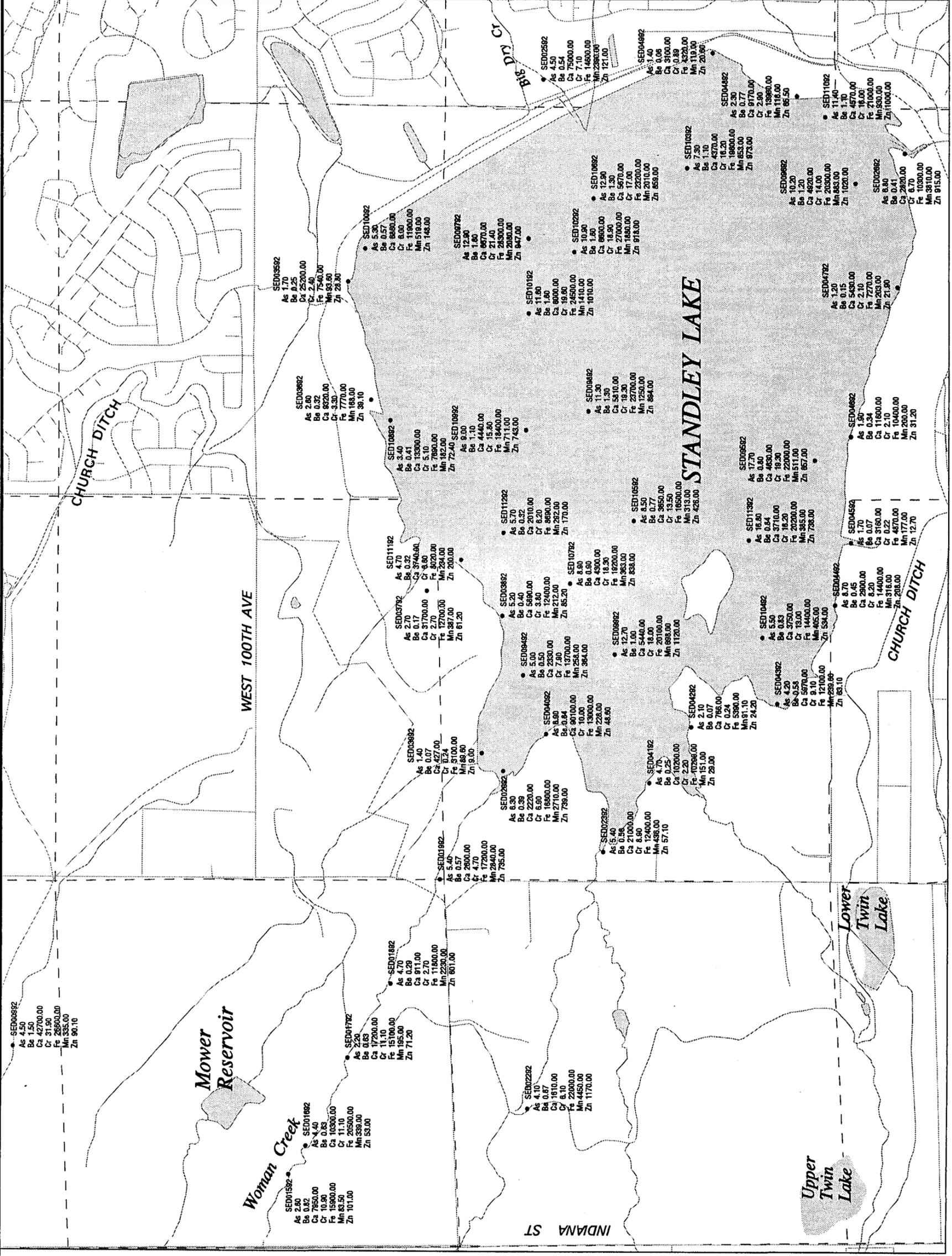


Figure F-3

# Analytical Results of Selected Metals for Sediment Samples

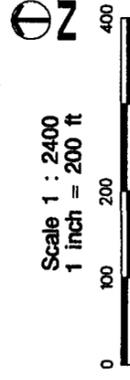
OPERABLE UNIT 3  
 IHSS 202 Mower Reservoir  
 ROCKY FLATS  
 ENVIRONMENTAL TECHNOLOGY SITE  
 U.S. Department of Energy

Analyte Symbols:  
 As Arsenic  
 Be Beryllium  
 Ca Calcium  
 Cr Chromium  
 Fe Iron  
 Mn Manganese  
 Zn Zinc

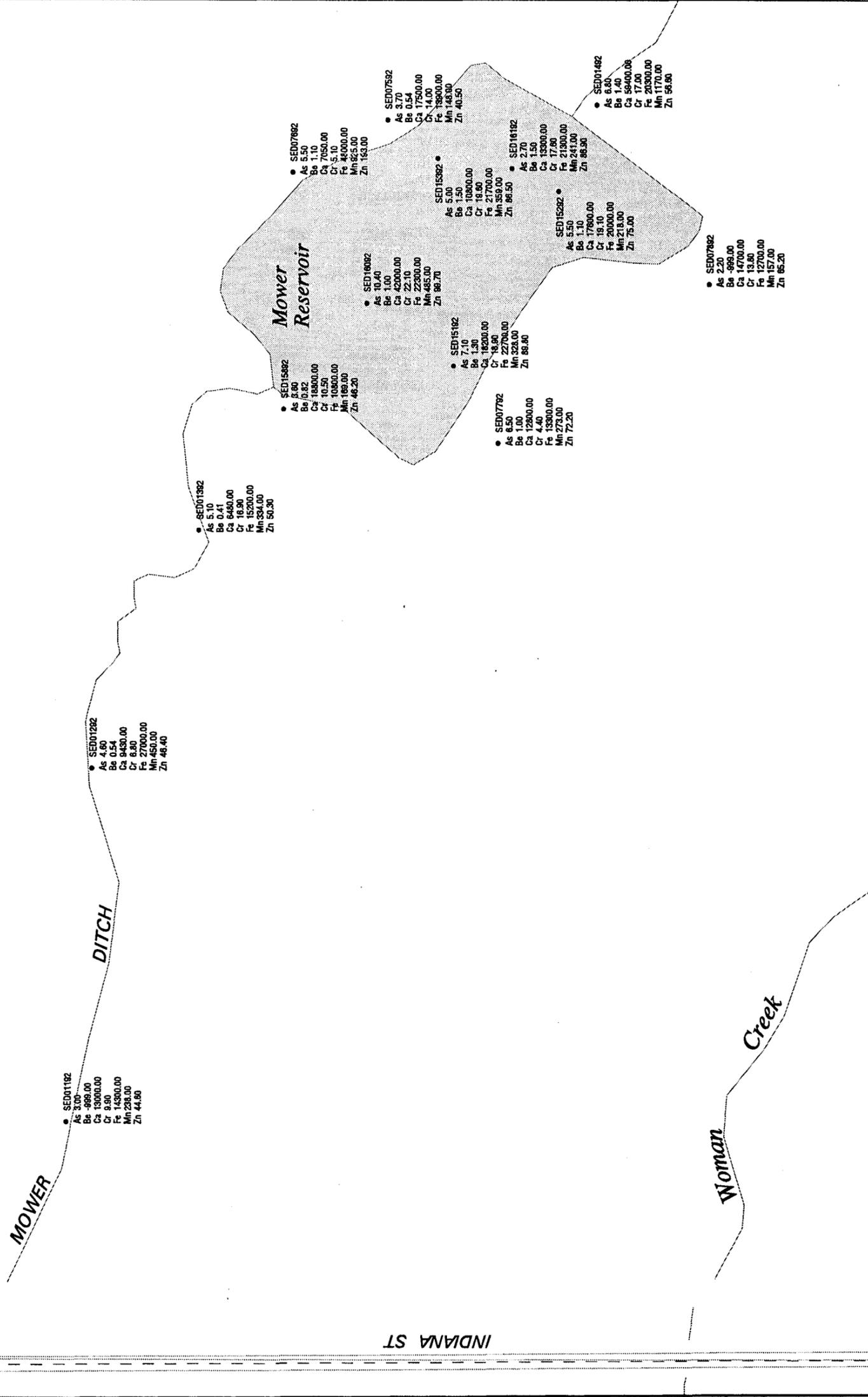
Units are mg/kg.

• 1992 Sediment grab sample

Mapping Sources:  
 Jefferson County Mapping Dept.  
 EG&G Rocky Flats  
 U.S. Geological Survey



Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.



U.S. DEPARTMENT OF ENERGY (ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE)

Figure F-4

# Analytical Results of Selected Radionuclides for Sediment Samples

OPERABLE UNIT 3  
IHSS 200 Great Western Reservoir  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy

Analyte Symbols:  
Am Americium-241  
Pu Plutonium-239/240  
U3 Uranium-233  
U5 Uranium-235  
U8 Uranium-238

Units are pCi/g.

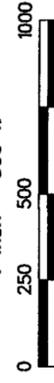
- 1992 Sediment core sample
- 1992 Sediment grab sample

Note: values of -999 indicate rejected data.

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

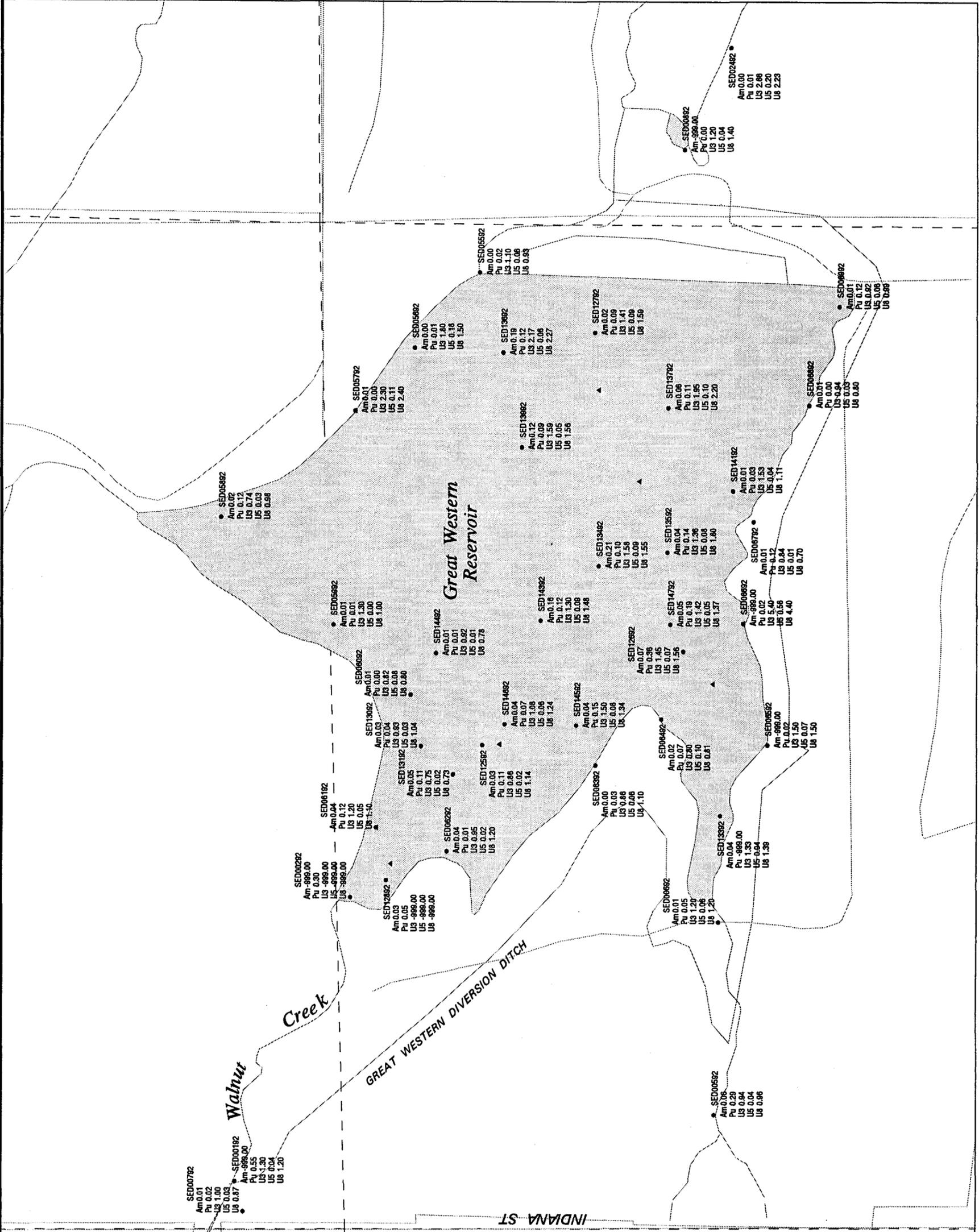


Scale 1 : 6000  
1 inch = 500 ft



SCALE IN FEET

Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.



( ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE )

U. S. DEPARTMENT OF ENERGY

Figure F-5

# Analytical Results of Selected Radionuclides for Sediment Samples

OPERABLE UNIT 3  
IHSS 201 Standley Lake  
ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE  
U.S. Department of Energy

Analyte Symbols:  
Am Americium-241  
Pu Plutonium-239/240  
U3 Uranium-233  
U5 Uranium-235  
U8 Uranium-238

Units are pCi/g.

• 1992 Sediment grab sample

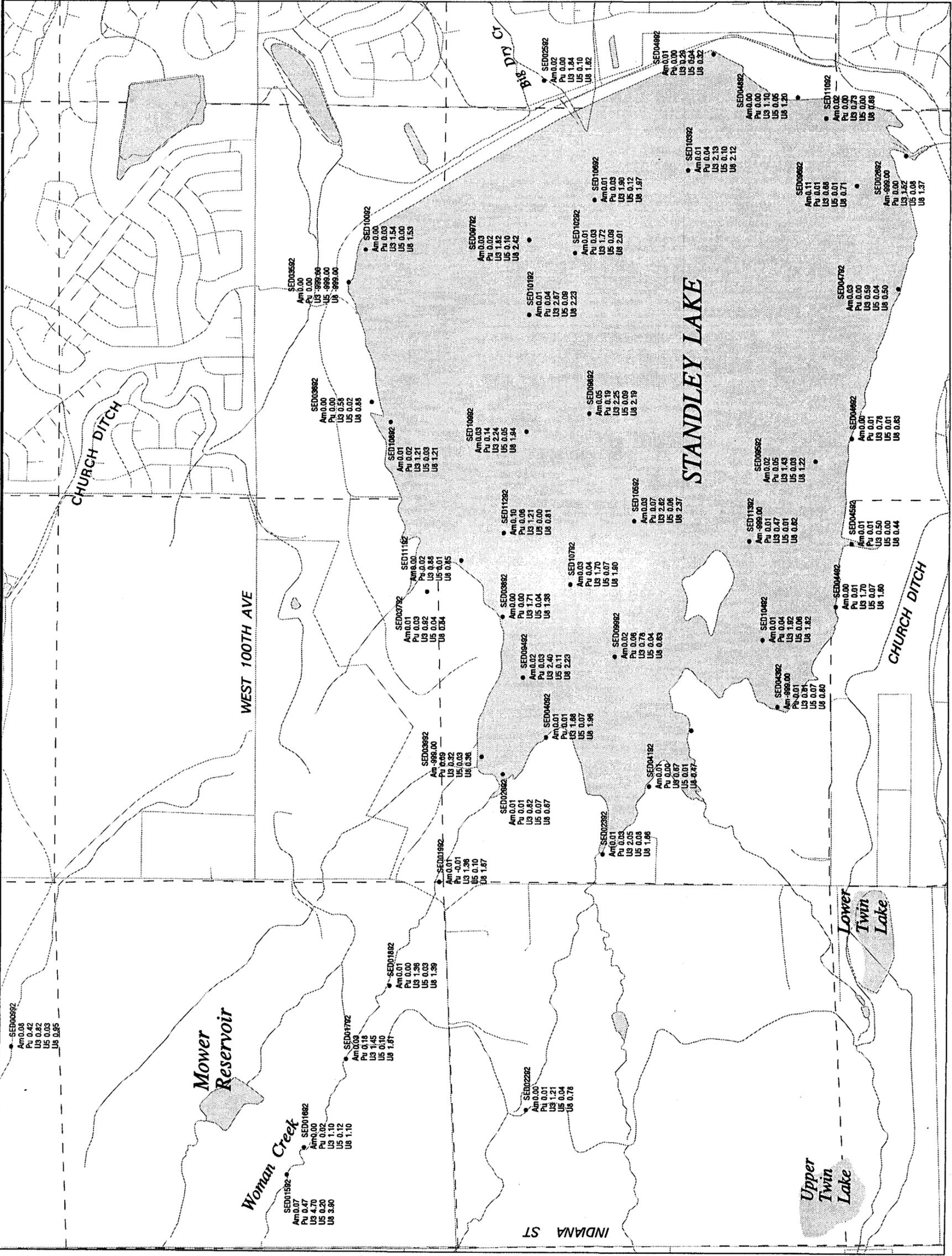
Note: values of .999 indicate rejected data.

Mapping Sources:  
Jefferson County Mapping Dept.  
EG&G Rocky Flats  
U.S. Geological Survey

Scale 1 : 15840  
1 inch = 1320 ft or 0.25 mi



Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.





**Figure F-7**  
**Analytical Results of Selected Metals for Surface Water Samples**

**OPERABLE UNIT 3**  
**IHSS 200 Great Western Reservoir**  
**ROCKY FLATS**  
**ENVIRONMENTAL TECHNOLOGY SITE**  
**U.S. Department of Energy**

Analyte Symbols:  
 As Arsenic  
 Be Beryllium  
 Ca Calcium  
 Cr Chromium  
 Fe Iron  
 Mn Manganese  
 Zn Zinc

Values are results for total metals. Units are ug/l.

• Surface water sample

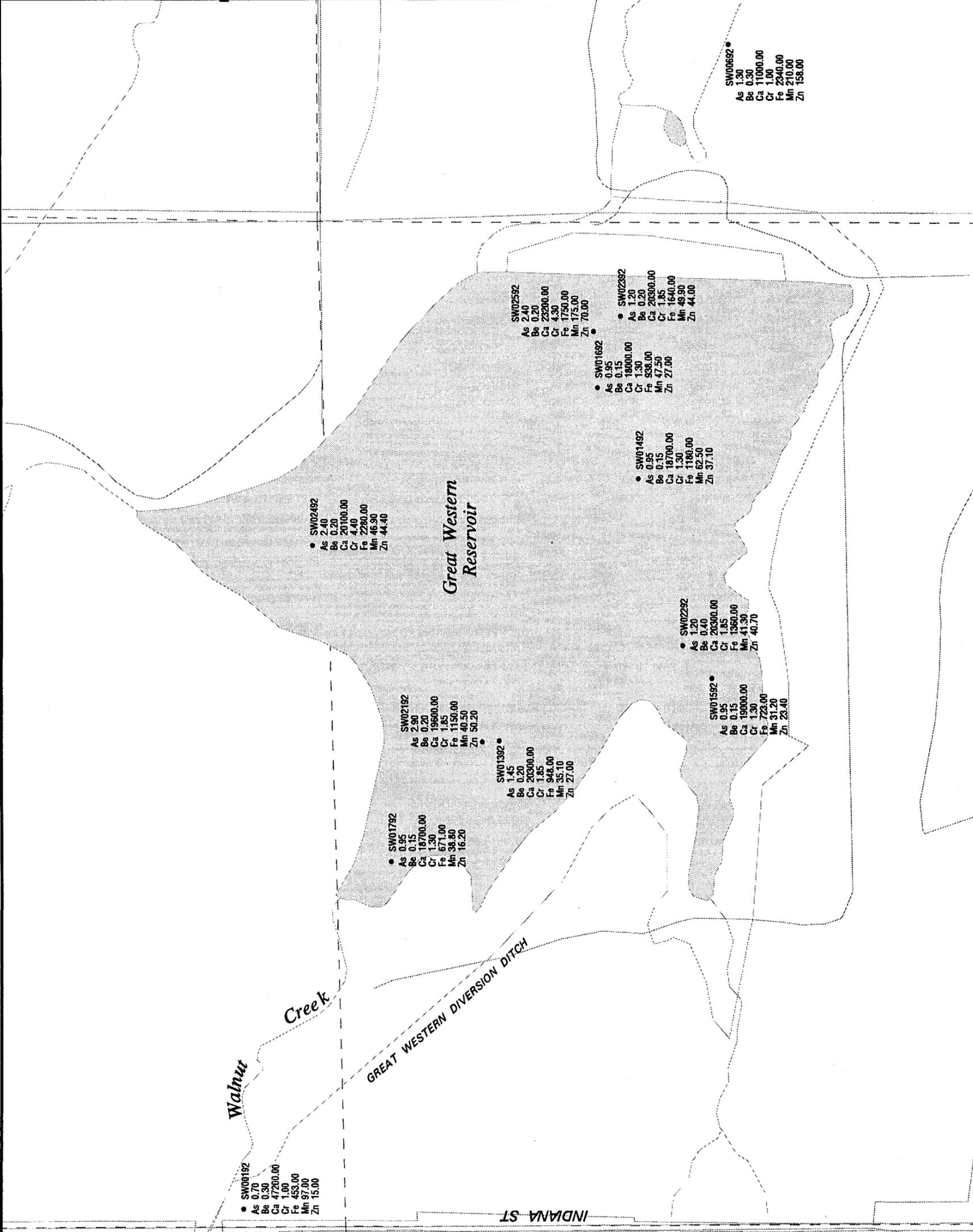
Mapping Sources:  
 Jefferson County Mapping Dept.  
 EG&G Rocky Flats  
 U.S. Geological Survey



Scale 1 : 6000  
 1 inch = 500 ft



Polyconic projection. 1927 North American datum. Colorado central zone state plane coordinate system.



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**Figure F-8**  
**Analytical Results of Selected Metals for Surface Water Samples**

**OPERABLE UNIT 3**  
 IHSS 201 Standley Lake  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
 U.S. Department of Energy

Analyte Symbols:  
 As Arsenic  
 Be Beryllium  
 Ca Calcium  
 Cr Chromium  
 Fe Iron  
 Mn Manganese  
 Zn Zinc

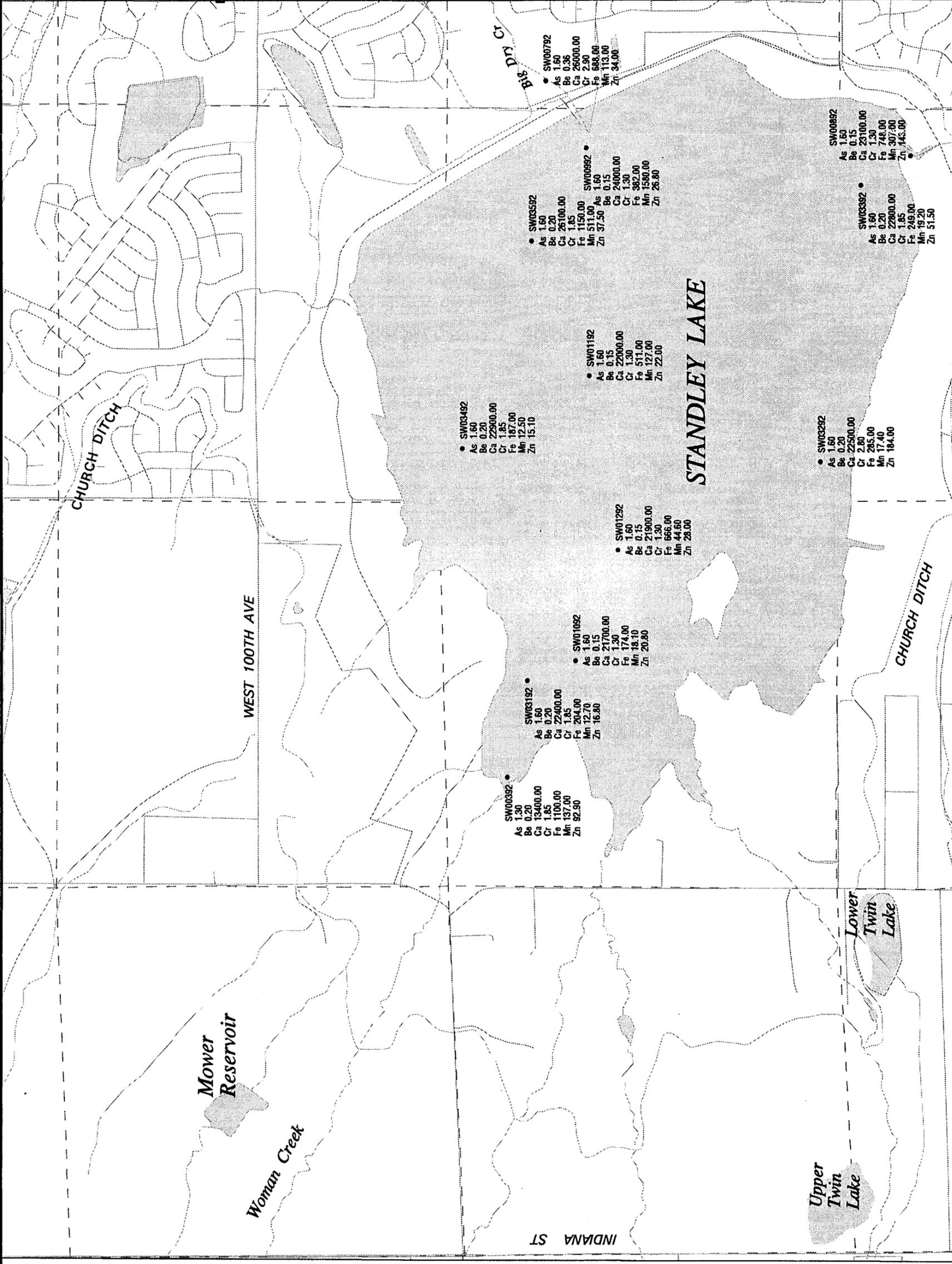
Values are results for total metals. Units are ug/l.

• Surface water sample

Mapping Sources:  
 Jefferson County Mapping Dept.  
 EG&G Rocky Flats  
 U.S. Geological Survey

Scale 1 : 15840  
 1 inch = 1320 ft or 0.25 mi

Polyconic projection. 1927 North American datum. Colorado central zone state plane coordinate system.



**Figure F-9**  
**Analytical Results of Selected Metals for Surface Water Samples**  
**OPERABLE UNIT 3**  
**IHSS 202 Mower Reservoir**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**U.S. Department of Energy**

- Analyte Symbols:  
 As Arsenic  
 Be Beryllium  
 Ca Calcium  
 Cr Chromium  
 Fe Iron  
 Mn Manganese  
 Zn Zinc

Values are results for total metals. Units are ug/l.  
 • Surface water sample

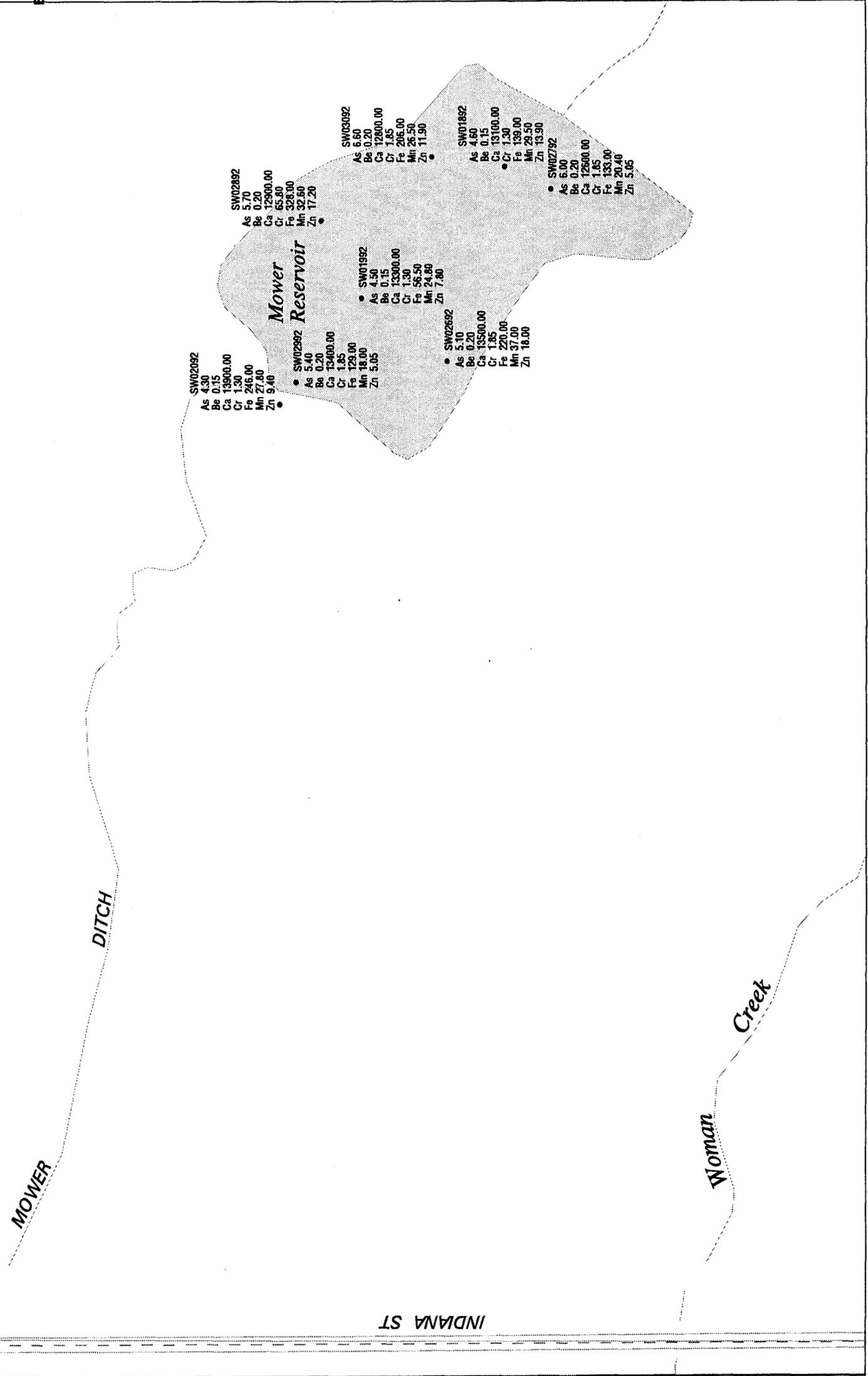
Mapping Sources:  
 Jefferson County Mapping Dept.  
 EG&G Rocky Flats  
 U.S. Geological Survey

Scale 1 : 2400  
 1 inch = 200 ft

SCALE IN FEET  
 0 100 200 400

North arrow symbol

Polyconic projection, 1927 North American datum, Colorado central zone state plane coordinate system.



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